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*THE SPHERE OF BACTERIOLOGY.**

IT is possibly a contemporary delusion that we are living in a period of unexampled mental activity. The life of the intrepid modern scholar affords opportunity for self-deception. If one becomes a member of a sufficient number of learned and quasi-learned societies, and attends committee meetings for an adequate variety of purposes, the impression of profitable intellectual endeavor may be prematurely acquired. There is much, however, to account for the prevailing sensation of breathless advance. The physiological and psychological accompaniments of a breakneck pace are not altogether lacking in the modern world, and there are bacteriologists in particular who will lend a credent ear to affirmations of the rapidity of scientific progress. However this may be, few can question that the development of the science of bacteriology has been marked by an unusual tempo. To those who have followed this development closely, discovery has trod upon the heels of discovery in bewildering succession. The scant thirty

* Read before the Section of Bacteriology, International Congress of Arts and Science, Universal Exposition, St. Louis.

years of its history have been crowded with feverish activities which have found their best justification in the results accomplished. At present the science touches nearly many human interests and sustains manifold and far-reaching relations to the whole body of natural knowledge. It is no matter for surprise that such should be the case with a science that owes its birth to a chemist, that concerns itself with microscopic organisms belonging both to the plant and animal kingdoms, and that extends its ramifying branches into the regions of medicine, hygiene and the industrial arts.

In several respects the history of bacteriology might be held to epitomize that of the other natural sciences or of the living organism itself. Advance in complexity of structure entails greater complexity of relations and adjustment; maturity has more extensive connotations than youth. Bacteriology is a relatively youthful branch of the stream of knowledge, but in late years it has perceptibly widened its banks. It has even encroached upon certain neighboring sciences. Modern physiography uses the term *piracy* to designate the capture by one stream of that portion of a watershed legitimately belonging to another stream. In the same way, one natural science, owing to peculiarities in its subject matter, in its evolutionary history or in the tools with which it works, may enter upon a piratical career and appropriate territory which for various reasons has remained unexploited by the science to which topographically it may seem to belong. This annexation of neighboring fields has been not uncommon among the natural sciences, and bacteriology has not shown itself free from the general tendency. A notorious instance of piratical conduct on the part of bacteriology is the virtual appropriation of the whole field of microbiology. Perhaps most familiar in this connection are the discoveries concerning the life histories of various microscopic animal parasites. The tracing out of the relations between parasites and hosts in Texas fever, malaria and dysentery has by no means been exclusively or even largely the work of zoologists. On the contrary, it is well known that much of the most important work in this direction has been carried out by bacteriologists and that the literature on these topics is chiefly to be found in the technical bacteriological journals. A recent instance of this tendency is the renewed study of the remarkable protozoa called trypanosomes, which has in large part been undertaken by bacteriologists and by bacteriological methods. Perhaps the most notable triumph yet accomplished in this field is the successful cultivation of these pathogenic protozoa outside of the animal body, a feat which has been achieved by one of the foremost of American bacteriologists. The exploitation of zoological territory by bacteriological workers is one of the many instances of successful borderland invasion and, like the Louisiana Purchase, illustrates the impotence of territorial lines to prevent natural expansion. Many reciprocal piratic inroads among the sciences are due to the acquisition by one science of new tools which, when workers become generally acquainted with their use, are found to be applicable to other problems in other fields. Bacteriological technique is one of these efficient tools the possession of which conduces to piracy; it can, however, never be forgotten that bacteriology itself owes its powerful equipment to a study of spontaneous generation which was undertaken primarily for the interest felt in its philosophical bearings.

Bacteriology stands in close relation to at least four other more or less defined fields of natural knowledge: to medicine, to hygiene, to various agricultural and industrial operations and pursuits and to biology

proper. Bacteriology, as has been often said, is the youngest of the biological sciences and perhaps for this reason has as yet contributed relatively little to the enrichment of the parent science. Morphologically the bacterial cell is so small and so simple as to offer many problems of surpassing interest but of great difficulty. The question as to whether a bacterium is a cell without a nucleus or a free nucleus without any cytoplasm or a cell constituted in the main like those of the higher forms of life has, to be sure, been practically settled in favor of the latter view. But there are other debated and debatable morphological questions to which up to the present no satisfactory answer has been given and to which our current microchemical methods are perhaps unlikely to afford any solution. On the physiological side, the achievements of bacteriology in behalf of general biology have as yet been far from commensurate with its potentiality. This may be partly because of its temporary engrossment in other seductive lines of research, partly because of the lack of workers adequately trained in bacteriological methods and at the same time possessed of an appreciation of purely biological data. It may be justly urged that a rich harvest of fundamental physiological facts waits here for the competent investigator.

There is no need to dwell in detail upon the manifold practical applications of bacteriology to the arts and industries. Particularly in agriculture and kindred occupations have the advances in bacteriology been immediately and intelligently utilized to bring forth in turn new facts and unveil new problems. The processes of cream-ripening and vinegar-making, the phenomena of nitrification, of denitrification and nitrogen-fixation, the modes of causation of certain diseases of domestic plants and animals, have all been elucidated in large measure by bacteriological workers. A new division of technological science, dealing with the bacteriology of the soil, of the dairy and of the barnyard, of the tan-pit and the canning factory, has already assumed economic and scientific importance.

It is often a temptation to distinguish radically between pure science and applied science and to look upon the latter as unworthy the attention of the philosophically minded. True science can admit of no such distinction. No thing in nature is alien to her. She can never forget that some of the most fruitful of scientific theories have been the outcome of the search for the utilitarian. Man's knowledge of the universe may be furthered in various ways. It is well known that the work of Pasteur was particularly characterized by applications to the problems of pure science of knowledge acquired in the study of the practical. One thing plays into the hands of another in wholly unexpected fashion. An attempt to improve the quality of beer gives birth to the germ theory of fermentation, and this in turn to the germ theory of disease; the chemistry of carbon compounds leads to the discovery of the aniline dyes, and these same aniline dyes have made possible the development of microchemical technique and thrown open spacious avenues for experiment and speculation; the attempt to obtain a standard for diphtheria antitoxin has resulted not only in the achievement of the immediate practical end, but in the discovery of unexpected theoretical considerations which have dominated the progress of an important branch of scientific medicine during the last five years. It will not be a hopeful sign for the advancement of science when the worker in pure science ceases to concern himself with the problems or avail himself of the facilities afforded by the more imminently utilitarian aspects of natural knowledge.

In the quarter century of its history

bacteriology has sustained close and mutually advantageous relations with the science of medicine. This has been the scene at once of its greatest endeavors and of its greatest triumphs. To recount these would be superfluous. There is hardly an hypothesis in scientific medicine that has not been freshened and modified, hardly a procedure in practice that has not been influenced by bacteriological conceptions. The experimental method in particular has been given new support and received brilliant justification. Experimental pathology and experimental pharmacology practically owe their existence to the methods and example of bacteriology. The security afforded by aseptic surgery has made possible physiological exploits that could not otherwise have been dreamed of, a pregnant illustration of the way in which applied science may directly further the advance of pure science. Conspicuous as these achievements of bacteriology have been, it can not be truly said that the field is exhausted. There is hardly an infectious disease of known or unknown origin that does not still harbor many obscurities. Some of the most difficult problems that medicine has to face are connected with the variation and adaptation of pathogenic bacteria. The phenomena of immunity, certainly among the most complicated and important that human ingenuity has ever set itself to unravel, still await their full description and interpretation. The study of the ultra-microscopic, or perhaps more correctly the filterable viruses, is being prosecuted with great energy and in a sanguine spirit. The extension of bacteriological method into the field of protozoon pathology has been already referred to and constitutes one of the latest and most hopeful developments in the study of the infectious diseases. Medicine, perhaps more than any other department of human knowledge, is most indebted to, and maintains the most intimate relations with, the science of bacteriology.

At the present time the relations of bacteriology to public hygiene and preventive medicine seem to me of particular importance, and it is upon this theme that I wish chiefly to dwell. Personal hygiene is not necessarily pertinent to this topic, but falls rather into the same province with the healing art. Matters of diet, of clothing, of exercise, of mental attitude affect the individual and contribute more or less largely to his welfare. But except in so far as the individual is always of moment to the community, they do not affect the larger problems of public hygiene. The pathological changes that take place in the tissues of the diseased organism and the methods that must be employed to combat the inroads of disease in the body of the individual patient must for a long time to come remain questions of supreme importance to the human race. But over and above the treatment and cure of the diseased individual, and the investigation of the processes that interfere with the proper physiological activities of the individual organism, rises the larger and more far-reaching question of the prevention of disease.

Racial and community hygiene are but just beginning to be recognized as fields for definite endeavor. The project may seem vast, but the end in view is undoubtedly the promised land. More and more will the problems of curing an individual patient of a specific malady become subordinated to the problem of protection. More and more will scientific medicine occupy itself with measures directed to the avoidance of disease rather than to its eradication.

Whatever else may be said of it, this is certainly the age of deliberate scrutiny of origins and destiny. Man no longer closes his eyes to the possibilities of future evolu-

tion or to those of racial amelioration. If we are to remain to a large extent under the sway of our environment, we can at least alter that environment advantageously at many points. We are no longer content to let things as we see them remain as they are. On the surface the wider relations of disease have often seemed of little significance as, before Darwin, the so-called fortuitous variations in plants and animals were considered as simple annoyances to the classifier; the causes of this variation were deemed hardly worth investigation. The rise and fall of plagues and pestilences have been readily attributed to the caprices of the *genius epidemicus,* and it has sometimes been thought idle to ascribe recurrent waves of infection to anything but 'the natural order.' Another phase, entered upon later and from which we have not yet entirely emerged, possesses its own peculiar perils. In meditating on the cosmos the agile mind is always tempted to fill in the gaps of knowledge with closely knit reasonings or fantastic imagery. The imaginative man of science still frequently finds himself beset with the temptation to erect an unverifiable hypothesis into a dogma and defend it against all comers. It is now fortunately a truism that a more humdrum and plodding course has proved of greater efficacy in advancing natural knowledge. Theories that stimulate to renewed observation and experiment have been of the greatest service, but unverifiable speculations have often been a barrier to further advancement. Metaphysics tempered with polemic is not science, whatever be its allurements.

If the attainment of a rational position in public hygiene, community hygiene or preventive medicine must then be regarded as the main objective point in the campaign against disease, it follows that the part played by bacteriology in this advance will be an important one. The relations of bacteriology to public hygiene are fundamental. The etiology of many of the most widespread and common diseases that afflict mankind is intelligible only through the medium of bacteriological data. The modes of ingress of the invading microorganisms, the manner of persistence of the microorganism in nature, the original source of the infectious material and all the varied possibilities of transmission and infection can be apprehended only through the prosecution of detailed bacteriological studies. It is only by this means that the weak point in the chain of causation can be detected and the integrity of the vicious circle attacked. Success will inevitably depend upon a thorough understanding of the circumstances governing and accompanying the initiation and consummation of the disease process. Yellow fever can not be suppressed by burning sulphur or by enforcing a shot-gun quarantine, the bubonic plague is not to be combated by denying its existence.

In the warfare against the infectious diseases a rational public hygiene is ready to avoid the mistake of beating the air. A preliminary survey of the possibilities reveals several distinct types of disease; those that are practically extinct or far on the road to extinction in civilized communities, those that remain stationary, or decline but slightly, and those that show a more or less consistent increase. The economy of energy would suggest that it is not a far-sighted policy for public hygiene to focus its endeavors exclusively upon those diseases that are yielding naturally before the march of civilization. The conditions under which civilized peoples live to-day are in themselves sufficient to render the foothold of many infectious diseases most precarious. What nation now fears that typhus fever will become a national scourge, or who looks to see the citizens of London driven into the fields by the Black

Death? It is of course true that the continuance of this immunity can be secured only by unremitting watchfulness, although so long as existing conditions of civilized life are maintained the recurrence of great epidemics will be relatively remote. The pestilences that once stalked boldly through the land slaying their ten thousands are now become as midnight prowlers seeking to slip in at some unguarded door within which lie the young and the ignorant. Already some once dreaded maladies have become so rare as to rank as medical curiosities, and their ultimate annihilation seems assured.

There are other diseases, however, that civilized life, or, at least, modern life, appears to leave substantially unchecked, and some that it even fosters. These may be considered as shining marks for the modern hygienist. The scale between hygienic gain and loss is always in unstable equilibrium. There is no such thing as consistent improvement all along the line. As Amiel wrote in his journal, 'in 1,000 things we advance, in 999 we fall behind; this is progress.' It is almost a biological axiom that progress in one particular entails loss in others. To maintain the efficiency of all parts of the complex of civilization calls for eternal vigilance. It may be that while we are waxing complacent over the fact that the opportunities for infection with certain parasites are diminishing and that other parasites are gradually losing what we vaguely denominate as their virulence, unforeseen and greater evils are raising their heads. The increasing exemption from certain diseases will itself lead to an increased prevalence of others as diversely vulnerable age-groups are formed. In general it will occur that the diseases peculiar to the advanced age-groups will increase as the diseases of childhood and youth succumb to hygienic measures. A different age-distribution of the population will bring in its train new problems of preventive medicine, which must be successfully solved if the issue is to be fairly met.

There are not lacking instances of a dawning consciousness on the part of mankind that the proper development of public hygiene involves a far more comprehensive view of its relations than has hitherto been taken. The study of tuberculosis is being approached by methods of unexampled broadness. We are just beginning to recognize the way in which the roots of this destructive malady are well-nigh inextricably interwoven with the whole social fabric. Bacteriological, architectural and economical data are all levied upon for contribution to our knowledge of what is universally recognized as one of the most important of all human diseases. Here, as elsewhere, the care and cure of the infected individual still looms large, but beyond and above this is beginning to be placed the prevention of infection, the drying up of the stream at its source. That for this heavy task public hygiene will require the aid of many workers in many different fields is abundantly evident. For all of them, however, bacteriology must furnish the only definite point of view. In the full consideration of the 'exciting causes' the tubercle bacillus can never be allowed to drop into the background. Given foul air, insufficient food, inhalation of dust, excessive and exhausting labor and the other deplorable accompaniments of modern industrialism, and it still must be constantly kept in mind that without the tubercle bacillus these predisposing causes would never result in a single case of tuberculosis. On the other hand, without these contributing factors, the tubercle bacillus would almost sink to the level of the negligible 'non-pathogenic organism.' Witness the impotence of the bacillus to produce infection or even maintain itself

in the tissues of those individuals able to live an outdoor life.

It is evident that in the case of tuberculosis the forces of civilization are on the whole working for its extinction rather than for its perpetuation. The available statistics demonstrate that before the modern movement for the suppression of the disease began, and, in fact, even before the discovery of the tubercle bacillus, consumption was already on the decline in widely separated parts of the world—in London, in Boston and in Chicago. It is, perhaps, significant that consumption is now one of the tenement house problems and that as such it occupies a strictly delimited field. As yet the campaign against tuberculosis has been a desultory one, waged by a few enthusiasts without adequate material or moral support on the part of the community at large, but signs are multiplying that this condition will be a transient phase. The comparative absence of intelligent, systematic endeavor for the suppression of disease is certainly a curious phenomenon in an age of otherwise extensive coordination and organized action. The executive talents and restless energy lavished on commercial, industrial and engineering projects may some day be turned to devising and carrying out hygienic measures. If it were necessary to find an argument in the economic value of human life it would be readily forthcoming. The recent movements for the study and suppression of tuberculosis mark one of the first attempts to apply bacteriological knowledge in a determined and radical way to a problem of public hygiene. As regards the ultimate extinction of tuberculosis, there may be more or less groping after ways and means, but there need be no misconception as to the scope of the problem.

There are other fields where a similar mode of procedure based on ascertained bacteriological facts and principles has been indicated and is being at least in part carried out. In typhoid fever the evidence from epidemiology has long pointed unmistakably to drinking water as being the chief vehicle of infection, and the first step towards suppression of this disease has been already taken in most civilized countries. The last half of the nineteenth century witnessed an improvement in the sanitary quality of public water-supplies which has diminished perceptibly the death rate from typhoid fever. This change has been in part effected by the introduction of water from unpolluted sources, in part by the installation of sand filters. To cite a few well-known cases. For five years before the introduction of a filtered water the annual typhoid fever death rate in Zurich, Switzerland, averaged 76; in the five years following the change it averaged 10. In Hamburg, Germany, for a corresponding period before filtration, the typhoid death rate was 47; after the change it fell to 7. In Lawrence, Massachusetts, under similar conditions the typhoid rate was reduced from 121 to 26, and in Albany, N. Y., from 104 to 38. A similar effect has been noticed where an impure water has been replaced by water from unpolluted sources. In Vienna, Austria, the abandonment of the River Danube as a source of supply in favor of a ground water diminished the typhoid fever death rate from over 100 to about 6. In the United States, the city of Lowell not long ago exchanged the polluted water of the Merrimac River for a ground water supply, with the result that the typhoid fever death rate was reduced from 97 to 21. In spite of the remarkable facts there has been a lethargic slowness in profiting by the lessons that they teach. Many communities have remained to this day unobservant and negligent, and, especially in the United States, the condition of the average public water supply

demands radical reform. A method that has not only reduced the deaths from typhoid fever by about 75 per cent., but has also reduced the number of cases proportionately, is worthy of universal adoption. If the fatality in all cases of typhoid fever was diminished, say, from 12 per 100 cases to 3, by the use of a new drug or an antitoxin the world would ring with the discovery. The introduction of a pure water supply has achieved an analogous reduction in the death rate and confers further the enormous benefit of preventing the occurrence of a similar proportion of cases. In the city of Albany, N. Y., the annual number of deaths from typhoid fever prior to the installation of a filter plant averaged 89 during a ten-year period; in 1902 there were but 18 deaths from this cause, representing a diminution not only of 71 deaths, but of over 700 cases.

Important as is the function of a pure water supply in preventing typhoid fever, it is now clear that public hygiene can not stop here. In some countries, as in Germany, for example, where the larger cities and towns are supplied in the main with water of a highly satisfactory character, there still remains a notable residue of cases of typhoid fever. These we know are due to contact infection, to contamination of raw foods, such as milk, oysters and the like, to the conveyance of the specific germ on the bodies of flies and to similar modes of dissemination. It is a fact full of significance that the existence of these various modes of spread is recognized, that they are held to be matters of public concern and that preventive measures are being instituted under expert bacteriological control for suppressing the existing sources of infection. One of the most difficult problems in this campaign lies in the prompt recognition and rigorous supervision of the mild and obscure cases. It may be comparatively simple to isolate and disinfect with thoroughness in the franker types of the disease, but it is not clear that the danger is most critical on this side. The application of searching and delicate bacteriological tests is often necessary to determine the suitable mode of action. The dependence of public hygiene upon bacteriological data and methods has rarely been better exemplified.

The vigorous warfare that is being waged against malaria in many tropical countries affords a further and striking illustration of the utilization of existing resources for the avoidance of specific infection. It is hardly necessary to reiterate the obvious truth that malaria constitutes the chief and, perhaps, the only serious obstacle to the colonization of the tropics by the white races. Political and economic questions of the gravest import to mankind are bound up with the fortunes of a protozoon and a mosquito. The complex life-cycle of the malarial parasite offers an unusual number of points of attack. As is well known, several distinct views are current as to the best way of interrupting the continuity of transfer between man and the mosquito. It is conceivable that by the destruction of the malarial parasite within the body of man the supply of parasites for the mosquito may be cut off and the circle broken at this point. If the mosquitoes are prevented from becoming infected, man is safe. It is claimed by the adherents of one school that this method has proved very effective in certain localities where it has been systematically employed. The extermination of the parasite in the blood of man by the administration of quinine certainly constitutes an important weapon in the armory of public hygiene, whether or not it prove to be the most efficient one or the most economical in execution. In this same category are to be put the attempts to prevent the infection of the mosquito by guarding malarial patients

against the bite of *Anopheles*. It is obvious that this plan may often be difficult of execution because of the impossibility of exercising efficient control over the movements of individuals suffering from latent or recurrent infection.

A second possibility consists in the general protection against mosquito bite of all persons dwelling in infected regions. The pestiferous insect may beat its wings in vain against the windows of a mosquito-proof dwelling; if it can not come near enough to the human being to inject the contents of its poisoned salivary gland, no single case of malaria will result. In parts of Italy, it is said, this mode of prevention has been practised with brilliant success in protecting railway employees, forced by the exigencies of their calling, to reside in highly malarious localities.

A third point of attack is presented in the possibility of destroying or at least arresting the propagation of the insect host of the malarial parasite. The extermination of a number of species belonging to a widely distributed and abundant insect genus may seem in itself a gigantic task to undertake. Remembering the ambiguous success that has attended the efforts of the human race to combat the ravages of certain insects injurious to agriculture, it is not easy to be sanguine concerning the speedy extinction of *Anopheles*. It is noteworthy that the most considerable triumphs attained along economic lines have been effected by the utilization of the natural enemies of the noxious forms. Efficient foes of *Anopheles* have so far not been discovered. There is no question, however, that in definite localities the number of individual mosquitoes belonging to malaria-bearing species may be enormously diminished by the destruction of the breeding-pools. The labors in this direction of English health officials in various parts of the world have been rewarded by a decisive decrease in the prevalence of malaria.

It will not escape remark that the effect of any one or of all of these protective measures is cumulative. A diminution in the number of mosquitoes, or in the number of persons harboring the malarial protozoon in their blood, or in the number of infected or non-infected individuals bitten by mosquitoes, will inevitably produce a lessening in the amount of malaria in a given region. This will in turn diminish the opportunities for mosquitoes to become infected and will at least put a check upon indefinite extension of the disease. It is significant that a high degree of success apparently attends the enthusiastic and persistent application of any one of the measures above instanced.

While malaria, typhoid fever and tuberculosis are to-day fairly in the field of view of public hygiene, such is not the case with a host of other maladies. A beginning is made here and there, but the vast majority of the diseases that affect mankind still lack an intelligent and organized opposition. This is partly because of insufficient knowledge. At the present time the apparent increase in pneumonia presents an imperative field for research. It seems unlikely that the available modes of attacking this disease are to be exhausted with attempts to improve individual prophylaxis. A clear understanding of the tangled web of statistical, climatic, racial, bacteriological and hygienic questions that environ this urgent problem of public hygiene is likely to come only through renewed investigation of the phenomena. If it is true, as some conjecture on what seems insufficient evidence, that the virulence of the pneumococcus is increasing, what is the bacteriological strategy suited to the emergency? Or if it turn out that an increase in the number of victims to pneumonia is largely made up of those who

have escaped an early death from tuberculosis, what procedure is indicated?

We can not always take refuge from the consequences of inaction under the plea of ignorance. There are few, if any, instances where public hygiene is utilizing to the full the knowledge that it might possess. Some responsibility rests upon those who are prosecuting bacteriological studies to see that the bearings of their investigations are not overlooked or neglected by those who are constituted the guardians of the public health. There is here no question of the sordid self-interest or commercial exploitation sometimes miscalled 'practical application.' In the long run the saving of life may play into the hands of the idealist. If John Keats had not died of consumption at the age of twenty-five the modern world would be a different place for many persons. It is not possible to estimate the loss to literature, science and art since the dawn of intellectual life which must be laid at the door of the infectious diseases. The relations of bacteriology to public hygiene, if properly appreciated and cultivated, will lead to an improvement in the conditions of life which will enhance both the ideal and material welfare of the race and will give greater assurance that each man shall complete his span of life and be able to do the work that is in him.

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EVOLUTION OF WEEVIL-RESISTANCE IN COTTON.

THE complexity of biological problems finds another excellent illustration in the evolutionary history of the relations between the cotton plant and the so-called Mexican boll-weevil. The present indications are that both the cotton and the weevil originated in Central America. The parasitism of the beetle is certainly very ancient, if, as seems to be the case, it has no other breeding-place than the young buds and fruits of the cotton plant. Of the severity of the parasitism there is ample evidence in Texas, the weevils being able to totally destroy the crop when the climatic conditions admit of their normal increase.

It was to have been expected, therefore, that in humid tropical localities where all seasons of the year are alike favorable the cotton would have been exterminated long since, or at least that its cultivation as a field crop would be utterly impracticable unless there were means of protection against the ravages of the insect. A definite intimation of the existence of protective adaptations was incidentally gained in eastern Guatemala in 1902 when no weevils were found in a field of the dwarf cotton cultivated by the Indians, although they were extremely abundant on a perennial 'tree' cotton a short distance away. The opportunity of making a detailed study of the subject during the second quarter of the present year has revealed an interesting series of protective adaptations resulting from the long evolutionary struggle for existence between the cotton and the weevil.

Reference has been made in another place* to the extensive system of extrafloral nectaries by which the cotton of eastern Guatemala has secured the active cooperation of the kelep or weevil-eating ant, but the Central American cottons and the Indians who have been cultivating them for thousands of years have developed many other expedients of structure, habits and culture which are of more or less assistance in resisting or avoiding the weevil.

The large leafy involucre of the cotton may have been at first a protective adaptation, though the weevils later learned to enter it easily. In some of the Guatemalan sorts the bracts are grown together at the base as though the evolution of a closed

* Report No. 78, U. S. Dept. Agric., p. 4, 1904.

involucre had begun. The hairy stems assist the ants in climbing, but impede the weevils, and thus increase the chances of capture. Prompt flowering and determinate growth enable an annual variety to ripen more seed. A perennial kidney cotton also escapes extinction by producing nearly all its blossoms at one season. In the central plateau region of Salama and Rabinal another perennial variety is cut back annually to the ground. New shoots spring up and the new crop is set within a short time, while the plants are still small enough to be cared for by the chickens and turkeys.

Another of these protective adaptations proves to be of such potential significance as to call for announcement in advance of a detailed report. The issue is nothing less than that the cotton plant, in some of its varieties, has finally developed a practical means of resisting and destroying the weevil larvæ. The process is in the nature of a varietal characteristic subject to increase by selection. The efficiency of the adaptation is such that a variety in which it appeared uniformly would afford no opportunity for the weevil to breed, and would thus be a means of exterminating it.

The facts are simple and have been thoroughly established during the department's entomological studies of the weevil for the past decade, but they have not been interpreted as a protective adaptation, nor as a character subject to further selective development. Messrs. Hunter and Hinds have reported* that in some instances as high as 41 per cent. of the boll-weevil larvæ fail to develop, as a result of what they have termed a 'gelatinization' of the tissues of the young bud or 'square.'

In the later stages the injured buds often appear as though filled with a structureless exudation, and it was not unnaturally supposed that the abnormality was the result of some disturbance of nutrition, or of bacterial infection. The material failed, however, to yield cultures of bacteria or to respond to experiments with fertilizers. The opportunity of examining the earlier stages of the phenomenon show that the conditions are far less abnormal than have been supposed, and that the 'gelatinization' is simply the result of very active growth or proliferation of the loose tissue of the tube or column, which in the flowers of the mallow family surrounds the style and bears the stamens.

The usual program would be for the young squares to fall to the ground when the larva has hatched and begun to eat out the pollen of the young bud. Proliferation involves the opposite procedure. Instead of ceasing to develop, the soft tissues of the staminal tube are stimulated in a manner analogous to that by which galls and other vegetable excrescences are formed. The cavity eaten out by the larva is filled and the little miscreant is either smothered in paste or, more likely, starved by the watery tissue which is certainly no equivalent for the highly organized protoplasm of the pollen, the normal infant-food of the young larva. But whatever may be the actual cause of death the practical fact is that the larva is killed, and apparently in every instance in which proliferation occurs.* A very little of the new tissue may be effective. When the cavity eaten out by the larva is small it is often neatly plugged by the new growth, and the flower may develop with no very great distortion, though the corolla generally shrivels up before reaching more than half the normal length. The young boll is not always

* Bull. 45, Bureau of Entomology, U. S. Dept. Agriculture, p. 96, 1904.

* In a few cases living weevil larvæ were found in squares which gave evidence of gelatinization, but there was always a second puncture from the outside, indicating that another egg had been deposited.

blasted, though it is often small and irregular in shape, perhaps as a result of deficient pollination. The stigma sometimes projects from the injured flower and might be fertilized normally, but in other instances the withered staminal tube and corolla remain closely wrapped about it, so that pollen could scarcely have entered. It would not be surprising if the more rapid and persistent growth which favors the new protective tissue were also accompanied by a tendency toward parthenogenesis. Or it may be that the irritation resulting from the presence of the larva stimulates the ovary as well. Moreover, proliferation is not confined to the bud; the same or a closely similar formation of tissue sometimes appears in the bolls, when these have been attacked by the weevils.

It is thus not merely a coincidence that the proliferation is most frequent in the quick-growing early varieties of cotton which are now prized in Texas as the best means of securing a crop. The weevil has conducted, as it were, a selection for rapidity of growth and early fruiting, and a further accentuation of vegetative energy has introduced the new protective habit. The destructive insect has, in effect, overreached itself, and induced a condition which with man's assistance may accomplish its own destruction.

It is not easy to conjecture any means by which the weevil could survive the general planting of a variety of cotton having proliferation as a constant character. If only the squares would 'gelatinize' the weevil might develop an instinct of postponing the egg-laying period until the young bolls could develop. The advantage might be partly temporary, though it would take many years for the weevil to meet the new demand, and it could never reach its present destructiveness because the delay of the breeding season, even for a week or two, would be an effective handicap, particularly if the weevils should continue to waste most of their ammunition on the squares, as they probably would.

How long it will take to secure a completely resistant cotton by selection can only be conjectured, since it is not known as yet how constant a character proliferation is in the plants which possess it. To lose no unnecessary time is, of course, of the greatest practical importance, not only for the industry at large but especially for the sake of the growers of the long staple cotton in South Carolina and Georgia. The longer season required by the Sea Island cotton will render entirely ineffective the cultural expedients by which a part of the crop of the upland varieties can be saved from the weevil; if the insect be permitted to reach the Atlantic coast Sea Island cotton will soon become an agricultural tradition.

This change of view regarding the nature of 'gelatinization' greatly alters the prospect of finding in tropical America a variety of cotton resistant to the weevil, a hope which seemed to be lessened by the discovery of the kelep or Guatemalan cotton-protecting ant. It is by no means impossible that varieties already exist in which proliferation has become a fixed character, and if not it will still be highly desirable to secure those in which the tendency is most strongly pronounced. In the ant-protected variety of eastern Guatemala, proliferation takes place very frequently, at least in the bolls, and the plant has other desirable features of quick, determinate growth and early bearing which may make it of value in Texas. It has the good qualities of King and other related varieties in accentuated form, though with a longer staple.

The dwarf Guatemalan cotton represents, as it were, the highest known development of the upland type. Even the annual character which has been looked

upon as a result of cultivation in temperate climates is a further instance of protective adaptation long ago secured in the tropics by the unconscious selection of the Indians. It was from the Central American region, evidently, that the other upland types came, but they represent an earlier stage of development, or have deteriorated because selection for resistant qualities has been relaxed in regions where the weevil was absent, as in our southern states. Other things being equal, the Indians would undoubtedly prefer the perennial 'tree' cottons, which continue to be cultivated in Mexico and Peru in localities so arid as to exclude the weevils, though it is not certain that they exist in Peru. Possibly there has never been a connected series of agricultural communities along which the weevil could follow into South America; the pest might never have reached the United States if cotton culture had not been extended into southern Texas.

But even if the varieties already known in Texas were to be utilized as the basis of selection, it is by no means beyond the limits of probability that a resistant, regularly proliferating variety could be secured within a decade, or even within five years, since cotton has been found to respond rather promptly to selective influence. The urgency of the matter would certainly justify an extensive campaign of selection, the problem being to find among the millions of plants which will be grown next season, some which possess in the highest degree the tendency to proliferation, and to secure seeds from them. The task, however, is peculiar, and more difficult than such experiments usually are, because there is little or nothing in the way of an external clue to the desired character. It may be necessary to cut open each infested square in succession to make sure that the plant is allowing no weevil larvæ to develop. And after the most promising plants have been located it may be possible to obtain seed from them only by artificially protecting them from the weevils. Otherwise the best stock might be lost if the weevils were very abundant. Indeed, this suggests a reason why 'gelatinization' has not become a fixed character already. Selection thus far has only been in the direction of proliferation in the bolls, since the proliferation of tissue in the buds would give a particular plant no advantage over its neighbors in the matter of seed production. It would enjoy no immunity from subsequent attack because it had not allowed any weevils to reach maturity. Weevils from other plants would continue to come to it, and the chances of ripening seeds would not be increased. There has been, in other words, no selective inducement for 'gelatinized' buds to become a uniform character except as they might be correlated with 'gelatinized' bolls, in spite of the fact that for killing the weevil proliferation in the buds is more important than that in the bolls.

These considerations reveal still another episode of evolutionary history, and may explain why it is that the variety protected by the ants, and the other 'upland' types which have originated in the same region, have the additional protective adaptations. It was only where the ants protected the cotton and thus perpetuated it as a field crop that these other considerations could have a cumulative effect. The other adaptations by which the tree cottons have maintained a desultory existence are of suggestive interest, but of apparently little practical importance, since no field culture of a perennial cotton seems to be maintained in any weevil-infested district.

In eastern Guatemala the cultivation of cotton as a field crop is strictly limited to localities suited to the ants, where they exist in such numbers as to give practical

protection. In Texas, however, cotton is grown under a great variety of conditions. The climatic vicissitudes of heat and cold, drought and flood are many times as great as in Guatemala, so that notwithstanding the unexpectedly great adaptability of the kelep it can not be expected to thrive equally well in all parts of the state, any more than does the weevil. Even if it be found that the ants can thrive, breed and establish new colonies in Texas, they will probably require many years to take full and effective possession even of the more favorable localities of this vast agricultural empire. Such a mitigation of the weevil's injuries would be, of course, of great practical value, and the work of the ants in destroying the larvæ of boll worms and leaf-worms might be only slightly less important in some districts. If, however, the hope of exterminating the weevil is to be cherished, or that of staying its ravages before it has laid the entire cotton industry of the South under tribute, there would seem at present to be no other alternative than to secure by discovery or development, within the next few years, a variety of cotton in which the larvæ of the boll weevil can not mature.

The present brief outline of the results of our study of cotton in Guatemala may be summarized by saying that the tendency to rapid growth and early fruiting, the large extrafloral nectaries which attract the ants, and the proliferation of the tissues of the young buds and bolls which kills the weevil larvæ, are protective adaptations, developed as a result of long contact between the cotton plant and the boll-weevil. The proliferation is not a mere pathological abnormality, but represents a definite evolutionary tendency, capable of further increase by selection. If this interpretation of the facts be correct it affords an intimation of a successful solution of the weevil problem by means of a resistant variety of cotton.

O. F. Cook.

Washington, November 4, 1904.

SCIENTIFIC BOOKS.

Dr. J. Frick's Physikalische Technik oder Anleitung zu Experimentalvortragen sowie zur Selbstherstellung einfacher Demonstrationsapparate. Siebente vollkommen umgearbeitete und stark vermehrte Auflage von Dr. Otto Lehmann. Friedrich Vieweg und Sohn. 1904. Pp. xxiii + 630.

The previous edition of this well-known standard work appeared in 1890–5 and consisted of two volumes, one of 725 pages, the other of 1,054. It is most interesting to note that there exists such a demand for a book of this character as to encourage the publishers to undertake the present seventh edition on such an enormous scale. This is to consist of two volumes; and of these the first part of the first volume only has so far appeared, having been published during the past summer. This is a volume of 630 pages and is illustrated with over 2,000 cuts. The scope of the present work as compared with previous editions may be estimated when it is noted that the subject matter contained in the volume under review had devoted to it in the last edition only 132 pages and 65 cuts.

As the title of the work indicates, it has a twofold object: one to suggest suitable experiments for class demonstrations, the other to give accurate instruction in the use of instruments, tools and technical methods. The subtitle of the first part of the first volume is 'The Rooms of a Physical Laboratory and their Equipment, together with an Introduction to the Use of the Latter.' There are five chapters: (1) 'Physical Demonstrations and the Laboratory Building'; (2) 'The Large Lecture Room'; (3) 'The Preparation Room and the Smaller Lecture Room'; (4) 'The Rooms for Apparatus and Assistants'; (5) 'The Rooms for the Mechanician and Janitor.'

There are numerous subdivisions of the chapters and full information is given in regard to almost every conceivable detail.

Methods of equipment of the lecture room with all kinds of power, and with water, gas, electricity, steam, etc., are fully discussed. Much information is given in regard to making rooms fire-proof and sound-proof; in regard to heating and ventilation; in regard to clocks, lighting, wardrobes, etc. All this is done with the utmost attention to details, and should prove of great assistance to architects, as well as to those responsible for the design and equipment of the laboratory.

In the chapter devoted to the description of the preparation room much extremely valuable information is given in regard to what may more strictly be called 'physical technique,' such as methods of working with leather and paper, glass-blowing, enameling, exposing and developing photographs, soldering of all kinds, and the use of various cements and waxes. This part of the book will, beyond a doubt, be of the most value to the worker in physics. Under suitable heads information of the fullest character is given in regard to the use of the lathe, of the forge, of the carpenter's bench, etc.

The fact that no detail, however insignificant, has been overlooked by the present editor of the book is shown by the inclusion in it of information concerning methods of tying knots, of pulling nails, of using even the simplest tools; and illustrations are given of such instruments as a crowbar, a hammer, a rubber glove and an oil-can. It may well be questioned whether such richness of detail is essential or advisable, but with a suitable index to the volume this ought to offer no serious objection. The need of an index, which is promised for the end of the first volume, is all the greater owing to the scanty information given by the table of contents, and to the fact that descriptions of many instruments are given in places where one would not expect to find them. Thus, under the heading 'Room for Delicate Work' is found the full description of Doleczalek's electrometer, of wire gratings and of the bolometer. These details may very well be given at this point of the book, as illustrations of the use of certain rooms in the laboratory; but without a complete index one might well search in vain for information.

The present edition of this great work is incomparably better than any of the previous ones. The illustrations are more numerous, and the letter press more detailed. Special attention is given to pieces of apparatus of recent design, and all the latest improvements are mentioned; references are made, when possible, to the historical development of various methods and instruments, but obsolete forms are not described. Full information is given as to places where every piece of apparatus mentioned, every tool and every machine, may be purchased, and the prices of both instruments and supplies are indicated.

The value of a work like the present one to every director of a laboratory, and to almost every worker in physics, is well shown by the fact that a seventh edition is now in demand, and so it need not be emphasized in this review. This present work is the most complete of its kind and gives the necessary information in the most convenient form possible. The only drawback to its general use comes from the fact that the publishers have seen fit to use German type instead of Roman.

J. S. Ames.

The Industrial and Artistic Technology of Paint and Varnish. By Alvah Horton Sabin, M.S., chemist for Edward Smith and Co., New York. New York: John Wiley and Sons. Pp. 372. Price, $3.00.

The work opens with two entertaining chapters upon the history and origin of varnish; these are followed by a description of the materials used in varnish and of its manufacture.

Especially noticeable are the parts treating of oils, paints and lacquers in China and Japan. The reviewer knows of no place where an equally interesting and instructive account of these Oriental arts can be found.

The specific value of the work consists in the attention paid to the protection of metals against corrosion and to water pipe coatings; these detail some experiments made upon large plates of steel and aluminum protected by various paints and varnishes when exposed to sea and lake water. These have not been

previously published and discussed in such a connected form, and are alone well worth the price of the book. Not less interesting and valuable are the portions devoted to antifouling paints, carriage and house painting and furniture varnishing.

Being a treatise on the industrial and artistic technology one scarcely expects to find much chemical information; there are, however, excellent chapters on the oils, particularly one on linseed oil by Dr. McIlhiney. It would have materially aided the chemist to have found an equally good and complete description of the gums used in varnish manufacture.

Throughout the entire work, one can not help being impressed with the wide practical experience of the author in the technology of paints and varnishes, and particularly with their applications.

The work should be in the hands of the architect, whether engaged in the erection of sky-scrapers or summer houses, of the civil engineer, having to do either with bridge or water works construction, of the naval constructor, and in fact of any one concerned with the preservation of wood or metal.

A. H. Gill.

GAUPP'S ANATOMY OF THE FROG.*

In preceding numbers of Science (Vol. VII., p. 463; X., p. 451; XV., p. 100) the earlier parts of this monumental work on the structure of the frog have received notice. The present part completes the whole, making a total of 1,738 pages, aside from preface, etc., entirely devoted to this one form. No other vertebrate, man excepted, has ever had such exhaustive treatment.

This concluding portion, 521 pages in all, is devoted solely to integument and sense organs, all treated in the same careful manner as the other systems, but, as would be expected, microscopic detail is emphasized here as in no other parts. Not only do we have a general account of the structure of the skin and its glands like that given in the first edition of the work (familiar in most laboratories in Hassal's translation), but we are given a good summary of the known facts, structural and physiological, of the color changes and details of the breeding-season changes in specific regions of the skin.

In treating of the sense organs each section is followed by a résumé of the development of each and an account of its functions. Thus in connection with the nose we have an account of the course of the air in the different parts of the nasal cavity, and the evidence to show that the frog is an 'air smeller' even when submerged. It is especially in the section pertaining to the ear that the largest proportion of new facts are given, since Dr. Gaupp has made certain parts of the otic region peculiarly its own.

In conclusion, we may say that the work is one which must be in every laboratory, and while we can hardly expect the whole to be translated we wish that at least certain portions, like that on the central nervous system, were more accessible to our students. Congratulations must be extended to the author on the completion of such a vast amount of work.

J. S. Kingsley.

* A. Ecker's und R. Wiedersheim's 'Anatomie des Frosches auf Grund eigener Untersuchungen durchaus' neu bearbeitet von Dr. Ernst Gaupp. IIIte Abtheilung, IIte Hälfte, pp. 441–961 + xi. Braunschweig, 1904.

SCIENTIFIC JOURNALS AND ARTICLES.

The opening (October) number of Volume 11, of the *Bulletin of the American Mathematical Society* contains the following articles: 'On Developable and Tubular Surfaces having Spherical Lines of Curvature,' by Professor Virgil Snyder; 'Addition to a Theorem due to Frobenius,' by Professor G. A. Miller; 'On Self-Dual Scrolls,' by Professor E. J. Wilczynski; 'The Opportunities for Mathematical Study in Italy,' by Dr. J. L. Coolidge; 'Vector Analysis' (Review of Henrici and Turner's Vectors and Rotors, of Kelland and Tait's (Knott) Introduction to Quaternions and of Fischer's Vectordifferentiation und Vectorintegration), by Dr. E. B. Wilson; 'The Mathematics of Insurance' (Review of Loewy's Versicherungsmathematik), by Dr. Saul Epsteen; Shorter Notices (Seliwanoff's 'Lehrbuch der Differenzenrech-

nung'), by Dr. Saul Epsteen; Notes; New Publications.

The November number of the *Bulletin* contains the following articles: 'Report of the Eleventh Summer Meeting of the American Mathematical Society,' by Professors M. W. Haskell and H. S. White; 'Report of the October Meeting of the San Francisco Section,' by Professor G. A. Miller; 'The Foundations of Mathematics' (Review of B. Russell's Principles of Mathematics and Foundations of Geometry), by Dr. E. B. Wilson; Notes; New Publications.

The General Index of the first thirteen volumes of the *Bulletin*, 1891–1904, compiled by Dr. Emilie N. Martin, has just been issued as a separate publication. The 80 pages comprise indexes according to authors, works reviewed, and subject matter, the last classified according to the Répertoire bibliographique des Sciences mathématiques. There is also an index of all papers read before the Society since 1891.

THE October number (Volume 5, No. 4) of *The Transactions of the American Mathematical Society* contains the following papers:

F. S. MACAULAY: 'On a Method of dealing with the Intersections of Plane Curves.'

J. M. PEIRCE: 'On Certain Complete Systems of Quaternion Expressions, and on the Removal of Metric Limitations from the Calculus of Quaternions.'

L. P. EISENHART: 'Three Particular Systems of Lines on a Surface.'

E. J. WILCZYNSKI: 'On Ruled Surfaces whose Flecnode Curve intersects every Generator in two coincident Points.'

J. I. HUTCHINSON: 'On the Automorphic Functions of the Group (0, 3; 2, 6, 6).'

H. F. BLICHFELDT: 'A Theorem concerning the Invariants of Linear Homogeneous Groups, with some Applications to Substitution Groups.'

F. MORLEY: 'On the Geometry whose Element is the 3-Point of a Plane.'

G. A. BLISS: 'Sufficient Conditions for a Minimum with respect to One-Sided Variations.'

H. L. RIETZ: 'On Groups in which certain Commutative Operations are Conjugate.'

M. FRÉCHET: 'Sur les Opérations Linéaires.'

H. TABER: 'On Hypercomplex Number Systems (first paper).'

This number also contains: Notes and Errata, Volumes 1, 3, 4, 5; Table of Contents, Volume 5; Indices by subject matter, authors and numbers, Volumes 1–5.

The Popular Science Monthly for November opens with an account of 'The International Congress of Arts and Science,' by Wm. Harper Davis, illustrated by many portraits of those who participated therein. The rest of the number is devoted to addresses delivered at the congress and includes 'Present Problems of Inorganic Chemistry,' by Sir William Ramsay; 'The Light of the Stars,' by E. C. Pickering; 'Fundamental Concepts of Physical Science,' by Edward L. Nichols: 'The Methods of the Earth Sciences,' T. C. Chamberlin; 'Utilitarian Science,' by David Starr Jordan, and 'The Evolution of the Scientific Investigator,' by Simon Newcomb. In the 'Progress of Science' the editor briefly reviews the work of the congress and incidentally queries whether or not the amount accomplished justified the expenditure. The papers read and meetings held were, after all, but a small part of the good accomplished. As in almost every gathering of scientific men, the real good was the bringing together and meeting of those who participated, and particularly the privilege enjoyed by the younger men of meeting the acknowledged masters in science. Papers may be read at any time, but the men who present them are often names only and devoid of the personality that results from actual acquaintance.

The Museums Journal, of Great Britain, for October, contains for its leading article an account of the 'Norwich Castle Museum,' by Thomas Southwell. The interest of the number, however, centers around a letter by E. Ray Lankester, on 'Museums and Nature Study,' in which he points out most admirably some of the purposes for which museums and their scientific staff exist. In this connection it may surprise some to learn that the British Museum has no lecture hall.

Another most important article is a communication from Luca Beltrami, included under the title 'A Mediæval Vestment,' in

which he draws attention to the ethics in the case of the cope of Nicholas IV., which was abstracted from the cathedral at Ascoli and has been purchased by J. Pierpont Morgan.

SOCIETIES AND ACADEMIES.

AMERICAN MATHEMATICAL SOCIETY.

During September and October the American Mathematical Society held three several meetings. Of these the first in interest and importance was the eleventh summer meeting, held at St. Louis on September 16–17, thus immediately preceding the congress of arts and science of the Louisiana Purchase Exposition. Nearly forty members of the society attended this meeting, and there were present also by invitation Professors Gino Fano, of Turin, who brought greetings from Italian colleagues, and Henri Poincaré, of Paris, who read a paper on 'Closed geodesics on a closed convex surface,' a subject which had attracted his attention on account of its importance in connection with the discussion of trajectories in celestial mechanics. A detailed account of the meeting will be found in the November number of the *Bulletin* of the society, which also contains a report of the meeting of the San Francisco section at the University of California, October 1. At the latter meeting the program included a conference on recent investigations on the teaching of elementary geometry.

The one hundred and twentieth regular meeting of the society was held at Columbia University on Saturday, October 29, with an attendance of twenty-four members. President Thomas S. Fiske occupied the chair. Nominations of officers and members of the council to be elected at the annual meeting in December were adopted and ordered placed on the official ballot. The committee on the financial support of the *Transactions* reported a favorable outlook, several universities already having promised assistance in the form of a subvention. The expense of publishing the *Transactions* has been $2,000 per annum, of which amount ten universities have thus far contributed one half, the balance being met by the society and by returns from subscriptions and sales. Committees were appointed to consider measures for providing for the increasing burden of administration and to audit the treasurer's accounts.

The following papers were read at the October meeting:

Dr. Edward Kasner: 'Contact transformations and related systems of curves.'

Dr. Max Mason: 'The doubly periodic solutions of $\Delta u + \lambda A(x, y)u = f(x, y)$.'

Professor E. B. Van Vleck: 'A proof of some theorems on pointwise discontinuous functions.'

Professor Henry Taber: 'Hypercomplex number systems.'

Mr. J. C. Morehead: 'Note on a theorem of Lucas on Fermat's numbers.'

Professor E. W. Brown: 'On the completion of the new lunar theory.'

Professor Virgil Snyder: 'Quintic scrolls having a taenodal or an oscnodal conic.'

Professor G. A. Miller: 'Groups of subtraction and division.'

The following new members have recently been admitted to the society: Mr. R. P. Baker, Union Academy, Anna, Ill.; Dr. W. H. Bussey, Evanston, Ill.; Dr. H. A. Converse, Baltimore Polytechnic Institute; Mr. A. M. Curtiss, State Normal School, Oneonta, N. Y.; Professor G. R. Dean, University of Missouri; Dr. E. L. Dodd, University of Iowa; Dr. Saul Epsteen, University of Chicago; Professor R. R. Fleet, William Jewell College, Mo.; Professor E. D. Grant, Michigan College of Mines; Mr. J. E. Higden, Shortridge High School, Indianapolis, Ind.; Dr. L. C. Karpinski, University of Michigan; Dr. O. C. Lester, Yale University; Professor Tullio Levi-Civita, University of Padua; Professor J. C. Lymer, Lawrence University, Appleton, Wis.; Professor W. F. Moncreiff, Winthrop College, S. C.; Mr. Arthur Ranum, University of Wisconsin; Mr. C. S. Sisam, U. S. Naval Academy; Miss Adelaide Smith, Huguenot College, Wellington, S. A.; Dr. Clara E. Smith, Yale University; Professor C. M. Snelling, University of Georgia; Professor Eduard Study, University of Bonn; Professor D. T. Wilson, Case School of Applied Sciences. The total membership of the society is now 480.

F. N. Cole,
Secretary.

AMERICAN CHEMICAL SOCIETY. NORTHEASTERN SECTION.

THE fifty-fourth regular meeting of the section was held Thursday evening, October 27, in the Lowell Building, Massachusetts Institute of Technology, with President W. H. Walker in the chair. About 135 members and guests were present. Dr. Harvey W. Wiley, chief of the bureau of chemistry, U. S. Department of Agriculture, gave an address on the 'Effects of Preservatives on Health,' in which he described the experiments made in Washington under his charge to determine the effect of boric acid and borax, when taken into the system daily with the food for a long period of time. The conclusion drawn by the lecturer was that the effect of the constant use of these preservatives was on the whole somewhat injurious, causing, in many cases, loss of appetite, headache, and resulting in a diminution of weight, and slight changes in the metabolism of phosphoric acid, nitrogen, fat, etc.

ARTHUR H. COMEY,
Secretary.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 588th regular meeting was held October 15, 1904, Past-president Dall in the chair.

The death since the last meeting of Messrs. A. Lindenkohl and F. G. Radelfinger was announced.

Mr. F. W. Clarke spoke on 'Chemistry at the International Congress of Arts and Science.' The papers read were of high character and on the chemical sides the congress was a decided success.

Mr. O. H. Tittmann gave a brief account of his work the past summer as one of the commissioners for 'The Demarkation of the Alaskan Boundary.' A strip of this line some 500 miles long by 20 to 30 miles wide had been surveyed by the phototopographic method in previous years, and the results had been mapped for the High Joint Commission in London; the findings of the commission had defined the boundary line, and the five field parties this summer were engaged in erecting monuments over a portion of it.

Mr. L. A. Bauer then described 'A Method of Disclosing System of Magnetic Forces Causing the Secular Variation of the Earth's Magnetism.' It was pointed out that until an analysis of the secular variation forces has been made in a similar manner to that employed by Gauss for the permanent magnetic field, it is useless to theorize as to the cause of the secular variation. Such an analysis has been undertaken by the Department of Terrestrial Magnetism of the Carnegie Institution, an exhaustive compilation and discussion of the available data being made for the entire earth. Some preliminary results of the analysis as applied to certain well-surveyed areas, as, for example, the United States, were given in order to show the fruitfulness of the methods employed. The system of magnetic forces causing the secular variation in the United States during the period 1885–95 operated in opposition to that of the permanent field, *i. e.*, it acted as a *demagnetizing* system of magnetic forces directed opposite to those of the earth's permanent magnetization.

CHARLES K. WEAD,
Secretary.

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

DR. ALES HRDLICKA presented a photograph of a recent Crow burial in Montana, showing a well-covered body lying on a platform elevated on four-forked poles.

Dr. Hrdlicka also showed two crania with the same variety of intentional deformation, one from Peru and the other from Vancouver Island. The Peruvian skull presents an extreme degree of deformation, which was produced by surrounding the infant's head with tightly drawn bandages. Strangely enough, Peru and a portion of the northwest coast of North America, including Vancouver Island, are the only localities where this rather complicated form of mutilation is found on the American continent.

Dr. Swanton gave a short account of the Tlingit Indians of Alaska whom he has recently studied. There were formerly about fourteen local groups of these people, divided into numerous families and, socially, into two exogamous clans, or sides. A small division

was found which belongs to neither of these latter. Anciently each group had at least one winter town, but scattered among many camps in spring and summer. All law was based on the principle of 'retaliation,' and they believed in a multiplicity of spirits who communicated with men through numerous shamans. The Tlingit and Haida languages are similar in form and are probably genetically related.

Hon. Ainsworth R. Spofford, of the Library of Congress, who has recently paid a visit to Spain, read a paper entitled 'The Spanish Race of To-day.' It was replete with historic data, and references to scenery, language and manners and habits of the natives. The characteristics of the people were shown to be politeness, observance of etiquette, and sobriety. The climate varies from cold in the north to heat in the south. This has marked influence upon the people, those of the north being austere, while those from the south are lively and pleasure-loving. Though illiteracy is common, the natives are shrewd; agriculture is neglected, lotteries are fostered by the state, and begging is a national trait. The mule is the beast of burden, there being 1,500,000 of them to 400,000 horses.

J. D. McGuire,
Acting Secretary.

THE TORREY BOTANICAL CLUB.

The club met at the New York Botanical Garden, October 26, 1904. The meeting was called to order at the usual hour, Dr. D. T. MacDougal occupying the chair.

The first paper on the scientific program was by Dr. N. L. Britton on 'Notes on the Flora of the Bahamas.' The speaker, in continuation of previous explorations, which were reported in *Torreya* for July, recently spent five weeks in the Bahamas, principally on the Island of New Providence.

About 950 native and naturalized species have been reported from the Bahama Islands, an unexpectedly small number, in part accounted for by the fact that most of the land does not reach an elevation of more than 25 feet, although on one of the outer islands a height of 400 feet is recorded.

The flora is remarkable in the very unequal distribution of species, some being recorded from only one key. It is related to that of northern Cuba, extreme southern Florida, and in a lesser degree to that of Haiti. While the collections have as yet received only preliminary study, it is probable that ten or twelve new species will be founded on forms formerly thought to be identical with Cuban or other West Indian species.

The speaker gave a brief review of the flora, noting among other facts the presence of but five Gymnosperms—a *Pinus,* three *Zamias* and a *Juniperus.* The lower Monocotyledones are but poorly represented.

Of the grasses about fifty species were collected; these have not been studied, but it was noted that they show characteristic forms in each of the plant associations of the island. One of the most interesting is the climbing bamboo, *Arthrostylidium capillifolium* Griseb., whose light green color gives a characteristic tinge to the coppices. Seventeen species of sedges, none new, are to be added to the published flora of the islands. The palms are abundant and interesting, five species being reported. There were eight or ten species of bromeliads, about twenty-five orchids, and four or five figs reported. Among the Nyctaginaceæ there are two trees heretofore referred to *Pisonia* but evidently not properly referable to that genus.

It was noted that most of the trees of the islands do not reach as great a height as they do in the Florida 'hammocks.' A water-lily, in habit resembling a small *Nelumbo,* and heretofore referred to *Castalia ampla* is of special interest. The coastal thickets furnished a beautiful species of *Parthenocissus* with scarlet pedicels. Among the abundant types were many Malvaceæ, Celastraceæ, Euphorbiaceæ, herbaceous Papilionaceæ and shrubby and arborescent Mimosaceæ. Numerous photographs and specimens were exhibited.

The second paper was by Dr. Marshall A. Howe, who spoke on 'The Algæ of some European Herbaria.' This was a general account of a trip undertaken during the past summer for the purpose of seeing and studying the historical types of American marine algæ pre-

served in certain foreign herbaria. The first stop was at Trinity College, Dublin, where are found the collections of W. H. Harvey, author of the 'Nereis Boreali-Americana,' and of several shorter papers on American seaweeds.

In England, the three principal herbaria visited were those of the British Museum, the Linnæan herbarium and that of the Royal Botanical Gardens at Kew.

In France, a few days were spent at Caen, in the department of Calvados, where are preserved the collections of several students of seaweeds, such as Roussel, Lamouroux, Chauvin and Lenormand. Of these, the herbarium of Lamouroux is of chief interest, containing the materials from which thirty or more American species were first described.

At Paris the collections of Montagne, of De la Pylaie, and of Decaisne, which are in possession of the Muséum d'Histoire Naturelle, were those chiefly studied, though a collection of Guadeloupe algæ issued by Mazé and Schramm was also examined. The next stop was Eerbeek, Holland, for the purpose of seeing certain originals of Kützing, now owned by Madam Weber-van Bosse.

In Oldenburg, Germany, a few types of Roth, and in Copenhagen a few of Lyngbye and of Vahl were seen. The longest stay of the trip was made at Lund in southern Sweden, where a month was spent in studying the numerous American originals of the two Agardhs, father and son, who were actively engaged in describing marine algæ for a period of ninety years. Specimens were taken to Europe by Dr. Howe for comparisons with the types.

Photographs were obtained of about three hundred of the types examined and these are expected to prove particularly useful, especially as many of the species have never been figured.

The next regular meeting falling on the evening of election day, on motion the club adjourned to the last Wednesday in November.

EDWARD W. BERRY,
Secretary.

THE SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE.

THE eighth regular meeting of the Society for Experimental Biology and Medicine was held on Wednesday evening, October 19, in the demonstration room of the Department of Physiology of Columbia University at the College of Physicians and Surgeons. Dr. S. J. Meltzer presided.

Members present.—Burton-Opitz, Calkins, Davenport,* Ewing, Flexner, Gies, Hiss, Lee, Levene, Levin, Lusk, Mandel, Meltzer, Park, Richards, Salant, Wadsworth, Wallace, Yatsu.

Members elected.—J. G. Adami, R. A. Hatcher, Yandell Henderson, G. N. Stewart, C. G. L. Wolf.

Scientific Program.†

1. *The accommodation of the eye,* with demonstrations. Professor THEODOR BEER, of the University of Vienna.

Professor Beer called attention to the facts that, in an eye constructed as a 'camera obscura,' accommodation is effected by (1) change of curvature of refracting surfaces, principally the lens, and by (2) change of distance between refracting mediums and image screen, principally distance between lens and retina. Change of curvature of refracting surfaces is always in the direction of *increase* of curvature. It may be observed in mammals, birds and reptiles (very few snakes). Experiments were carried out before the society to show the increase of curvature of the lens in the eye of the water turtle. Accommodation by change of distance between lens and retina is effected, for objects at a distance, by (*a*) a movement of the lens toward the retina or by (*b*) a movement of the lens toward the cornea. The former is shown in cephalopods and fishes, the latter in amphibia and most snakes. In the eye of the fish there is a muscle, *Musculus retractor len-*

* Non-resident.

† The abstracts given in this account of the proceedings have been greatly condensed from abstracts given to the secretary by the authors themselves. The latter abstracts of the reports may be found in current issues of *American Medicine* and *Medical News.*

tis Beer, which draws the lens toward the retina. In amphibia and most snakes, the lens is moved toward the cornea away from the retina by changes of the intra-ocular pressure.

2. *Preliminary communication on the composition of the liver after subcutaneous injections of liver extracts.* P. A. Levene and L. B. Stookey.

Rabbits were treated with saline liver extracts. The autolytic powers of the livers of such animals were compared with the autolytic powers of livers from normal animals, and were found to be undiminished. The livers of the treated animals contained smaller proportions of nitrogen, but larger proportions of non-coagulable proteids, of non-basic nitrogen and of ethereal extract, than the livers of the control rabbits. Water and carbohydrate contents were unaffected by the treatment.

3. *Retransformation of negatively heliotropic animals (Gammarus pulex) into positively heliotropic animals by chemical means.* Jacques Loeb. (Presented by Simon Flexner.)

Professor Loeb recently succeeded in finding an instance of the transformation, by chemical means, of the sense of heliotropism in animals. He has observed that if one puts suddenly a large number of *Gammarus pulex* into distilled water or into common tap water, they all become at first very negatively heliotropic. These negatively heliotropic animals can be transformed instantly into positively heliotropic animals by the following substances: (1) many of the anesthetics of the fatty series; (2) many acids, except very weak ones like boric acid; (3) certain salts, like ammonium salts. The strengths of solution which effect this change instantly are, for example, ethyl acetate, $m/50$; ether, $m/6$; ethyl alcohol, $5/2m$; paraldehyd, $m/10$; hydrochloric, oxalic and acetic acids, $m/500$; boric acid, $m/10$; ammonium chlorid and ammonium hydroxid, $m/125$. Professor Loeb ascribes his results to chemical actions rather than to osmotic influences.

4. *Trypanosomes and bird malaria.* F. G. Novy and W. J. MacNeal. (Presented by Gary N. Calkins.)

Two genera of malarial parasites were studied—*Plasmodium* and *Hæmoproteus*—and four new species were distinguished, viz., *Plasmodium Vaughani, Hæmoproteus MacCallumi, H. Sacharovi* and *H. Rouxii.* The first is found in robins, the second and third in mourning doves, the fourth in sparrows.

The culture method is the best means of differentiating Trypanosomes as well as for detecting them in the blood.

Schaudinn's contention that *Halteridium* forms are but sexual phases of *Trypanosoma* is not confirmed, but, on the contrary, evidence is accumulated against it. For example, the culture method shows the existence at one time and in one culture of forms which Schaudinn described as *Halteridium* and as *Spirochæta* or Danilewsky's 'leucocytozoon.' One possibility of error in Schaudinn's results is that he worked with 'mixed cultures' in the mosquito.

5. *The gradual decrease in bacteria of the production of agglutinable substance.* William H. Park.

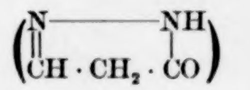
Dr. Park observed a diminution and finally almost a complete lack of development of agglutinable substance in bacteria grown in a serum rich in agglutinins and immune bodies. This observation is interesting both as showing a rapid variation in bacteria of essential characteristics and as possibly indicating one means of adapting themselves to resist destruction in the living body, since the bacteria which cease to produce agglutinable substance and probably, also, less substance with affinity for other anti-bodies, might be considered less vulnerable to these substances. Dr. Park's explanation of the process is that there are substances in the serum which attack certain parts of the bacteria, such as the agglutinable substance. With the increase of bacteria in the serum, those which produce the least of these substances are least inhibited and therefore develop most rapidly. When cultures are made from serum solution to serum solution daily, a gradual differentiation takes place until finally bacilli producing almost no agglutinable substance develop.

6. *Some Mendelian results in animal breeding.* C. B. Davenport.

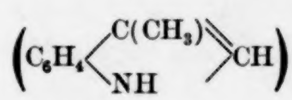
The essence of Mendelism in inheritance is its alternative character. In this it is opposed to blending inheritance (as in human skin color), which has been regarded as the typical sort of inheritance. At the Station for Experimental Evolution of the Carnegie Institution certain new cases of non-blending inheritance have already been found. Among sheep it appears from Dr. Alexander Graham Bell's records that the offspring of two black sheep are (probably always) black, although one or more of the grandparents were white. It looks as if black color (like albinism) might be recessive. Among canary birds it is found that, of the offspring of crested and of plain headed birds, some are crested and some are not. Poultry have been studied because of the numerous characters they exhibit. When a Japanese long tailed, clean legged cock was crossed on a white bantam hen, the two surviving offspring were highly colored like the father and had abundant feathers on the legs like the mother. The crested characteristic of poultry is peculiar, being sometimes dominant, and sometimes (apparently) blending with the crested condition when the cross is made.

7. *On the decomposition products of epinephrin.* JOHN J. ABEL and R. DE M. TAVEAN. (Presented by WILLIAM J. GIES.)

The empirical formula, $C_{10}H_{13}NO_3 \cdot \frac{1}{2}H_2O$, adopted by Professor Abel for that member of the epinephrin series which he has called epinephrin hydrate (the adrenalin of Takamine) is, at present, the subject of an acute controversy. In this report special attention was drawn to the fact that the $\frac{1}{2}$ H_2O of the above formula has always been regarded by Abel as *water of constitution* and *not* water of crystallization, as his opponents have apparently taken for granted. The basic substance, $C_3H_4N_2O$, which is obtainable equally from both forms of epinephrin, has been decomposed, by treatment with caustic potash, into ammonia (NH_3), methylamin ($CH_3 \cdot NH_2$), and methylhydrazin ($CH_3 \cdot NH : NH_2$). The last degradation product is of great importance in throwing light on the chemical constitution of the new base, $C_3H_4N_2O$. Its appearance, under the circumstances referred to, proves that the two nitrogen atoms of this base are directly combined one with the other, and suggests, among other things, for this base a ring structure such as is found in bodies of the pyrazolon



series. Small quantities of skatol



have been obtained on fusing epinephrin hydrate with caustic alkalies. Further investigation, particularly an analytic study of epinephrin hydrate prepared in an atmosphere of hydrogen, is in progress.

WILLIAM J. GIES,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE MEMBERSHIP OF THE AMERICAN ASSOCIATION.

THE writer was recently dining with friends, none of whom is engaged in scientific work in the narrower sense of the term. The American Association came up for discussion, and one of them said that he would like to become a member, but did not know how to arrange it. I said that I should be glad to nominate him for membership, and then asked the others if they would consent to be proposed for membership. There were in all seven; four consented to join the association, one was already a member, one took the matter under consideration and one declined. They were all surprised, so far as I remember, to learn that the dues were only three dollars and that SCIENCE is sent without charge to members. I venture to communicate this experience to SCIENCE because it seems to me that the conditions would be similar in any group of intelligent people. If each member of the association would ask two of his friends to join the association, at least one of them would be likely to accept, and the membership of the association would be doubled, much to the advantage of the association and the progress of science in America.

X.

AN ARTIFICIAL ROOT FOR INDUCING CAPILLARY MOVEMENT OF SOIL MOISTURE.

To the Editor of Science: The article in Science of October 27, 1904, page 566, under the above title calls for some comment on account of the fact that it does not, clearly and certainly follow, either from the evidence presented in the paper or from the conditions of the experiment, as stated, that the movement of soil moisture observed was in any way the result of capillary action. The subject of the paper is an important one, and perhaps a fuller statement of the conditions and observations will make the position taken by the authors tenable; but, from the evidence presented, it appears that the flow of water observed may have resulted solely from percolation, induced by the suction developed by the partial vacuum maintained in the filter chamber.

The authors state that 'When a tube of this kind is moistened, so that the pores are filled with water, and the tube is protected from evaporation, it can be exhausted to a pressure equal to the vapor pressure of water, and, if connected to a two-liter receiver, it will maintain that pressure for a day or more without sensible loss.' They also state that such 'A tube in good condition, when immersed in water and exhausted, will take up water at the rate of 50 grams per minute.' From these two statements it appears that the texture of the filter was sufficiently close so that, when wet, it was air-tight against a pressure of one atmosphere; but that when the capillary power or surface tension of the outer layer of the filter was rendered nil by immersion in water the flow into it was 50 grams per minute under the pressure which before gave no movement. It appears, therefore, that an essential condition of flow is the supersaturation of the outer wall of the filter, which, in effect, is equivalent to immersing it in water. It can hardly be assumed, however, from the evidence of the paper, that capillarity within the soil unaided is capable of supersaturating the wall of the filter where the soil is brought in contact with it and of maintaining it in this condition for days together. It is to be expected, however, that the placing of the outer wall of the filter in close contact with the soil did have the effect of practically augmenting the thickness of the wall, causing the filter to stand in the soil as a porous curbing to a well. When so placed, the capillary soil moisture may be expected to join with that of the wall of the filter, thus reducing, within the areas of good contact, the power of surface tension to withstand the suction from within; hence, along those lines, could be established a flow exactly as if the filter had been immersed in water, but purely through atmospheric pressure, capillarity taking little or no part in the movement. As the water escaped from the soil into the filter the reduced pressure would spread outward, and this would permit the soil air to sweep more water toward the filter and thus maintain the supersaturated condition about its wall until the soil moisture was so much reduced as to leave the soil open enough to permit air to come in contact with the filter; thus restoring, in effect, the condition of the filter described in the first quotation, with the wall only capillarily saturated and under which no flow took place. We do not feel, therefore, that the evidence which the authors present in the article referred to is sufficiently conclusive to warrant the views there expressed, or that they have succeeded in devising an artificial root which, in any essential way, can be said to represent or measure the natural movement of soil moisture in a soil toward an active root.

There is no doubt that if a method could be devised which would enable the rate of movement of soil moisture in the different soil types to be measured, under field conditions, an important advance could be made; but it is important to recognize that, even if it shall appear that the flow of water in the cases cited was due to capillarity, unless the method can be made capable of reducing the water lower than 17 per cent., in a soil whose maximum is 20 to 22 per cent., investigations made with it can have but a limited value. The force of this remark will be seen when it is pointed out that the lowest limit of moisture, in the soil experimented with, at which the flow ceased, was at least not lower than

the maximum amount the soil should contain, except for short intervals, in order to secure the best growth.

But even if the author's conclusions be not correct regarding the cause of the flow of water in the experiment, the line of investigation is important in that it has provided a means of securing water from field soil, perhaps, in a somewhat more concentrated condition than occurs in natural drainage and permits the sample to be taken where its history may be very definitely known; and it is to be hoped that they and others will apply the method in investigating the character of soil extracts thus obtained. We regard it extremely doubtful, however, that either the concentration or the composition of solutions so procured will be found to be the same as that which closely invests the soil grains or the root hairs at the same place and time. Certainly, if the movement is a capillary one, the observations recorded in the bulletin* on the 'Movement of Water-soluble Salts in Soils' indicate that very notable changes in the composition of the solution may take place as a result of the translocation. Our own observations also show that when only small quantities of some solutions are forced through such filters the concentration may be measurably changed.

F. H. KING.

MADISON, WIS.,
November 2, 1904.

* 'Investigations in Soil Management,' by the author, Madison, Wis.

HYBRID WHEATS.

TO THE EDITOR OF SCIENCE: In my original paper on hybrid wheats (Bull. 115, O. E. S.) the second generation of crosses between long-head varieties (*Triticum vulgare*) and club wheats (*T. compactum*) were divided into long, short and intermediate heads, these three types occurring in the proportion 1 : 2 : 1. Subsequent examination of later generations of these wheats, all of which continue to obey Mendel's law quite strictly, leads me to believe that the short head of the club wheats is really a dominant character, and that the apparent intermediate character of the heads of the heterozygotes of the several generations of hybrids is due to the greater vigor of the heterozygote individuals. It was found in the third and later generations that the long and intermediate heads could be separated without error, as shown by the purity of the long heads next year. But there were many small errors in separating the intermediate and short heads. If the latter separation had been perfect, the short-head type should have reproduced true to type. But in a majority of the plats supposed to contain only short heads, a few long and about twice as many intermediate heads were found, indicating that in most cases one or more intermediates had been selected with the shorts the previous year. When the seed of each plant was kept separate, this difficulty disappeared, each plant behaving either as a pure short head type or as an ordinary heterozygote.

One of the most interesting results which subsequent study of these hybrids has brought to light is the apparent effect of hybridization on the variation of single characters. For instance, the length of head of the long-head parent of the hybrid is fairly uniform, but in the hybrid this character varies between wide limits. The same is true of the length of the short or club heads. In the parent club variety the heads are fairly uniform in length; but in the pure short-head progeny of the second and later generations some of the heads were less than one fourth the length of the ordinary club heads. This induced variability of a character which has recently passed through the stage of what we may call heterozygosis probably accounts for the errors made in separating the intermediate and short heads above referred to. It is also of capital importance to the practical breeder. Those who are so situated as to attempt it will find an interesting problem in the effect of selection in fixing these variable characters, should the power of yielding large quantities of seed be rendered highly variable by hybridization, and should we be able to fix unusual yielding power thus induced, we could establish races of great economic value.

W. J. SPILLMAN.

U. S. DEPARTMENT OF AGRICULTURE.

GERMANY AND THE METRIC SYSTEM.

To the Editor of Science: In a recent issue of your journal a correspondent repeated the statement that the weights and measures of Germany were changed in 1870 from the old to the metric standards in a very short time; as he expressed it, it took "if not a fortnight, certainly only a few months, to make the 'masses' familiar with it, and about a year after the introduction there were but a few old and decrepit people that had been unable to master it."

This statement has frequently appeared in but a slightly modified form and backed by more or less high authority. Thus:

Lord Kelvin in the House of Lords, February 23, 1904: In Germany, France and Italy no inconvenience resulted from the introduction of the metric system, and there was no such thing as a complaint. The change in Germany occupied only two years. Sir W. Ramsay wrote: 'I was in Germany during the change there; it gave no trouble whatever and was recognized within a week.'

A witness before the Committee on Coinage, Weights and Measures at Washington, February 6, 1902: In talking to my head man about it—strange to say, we have one employee in a very important position, a German, who was in Germany in a somewhat similar position at the time the metric system was made compulsory there—he informed me that there is no real difficulty in making the change.

William Mauer, Secretary of the Germania Mills, Holyoke, Mass: The writer lived in Germany in 1871, when that country adopted the metric system, which gave great satisfaction, and the German population regretted at that time that they had not had the system long before.

Under any conditions such a radical change in the weights and measures of a country would be a cause of wonder. The very rapidity with which it is said to have been effected excites incredulity, which neither the eminence of the authorities who vouch for it nor a knowledge of the thoroughness of the rule of blood and iron by the Bismarckian régime can wholly remove. This doubt is further strengthened by testimony as to present conditions in Germany, of which a few examples follow:

Friedrich Frowein, Barmen, 1901, 'Kalkulator fuer Artikel der Textilbranche,' a handbook for textile workers. Gives complicated formulas for converting different standards, including the Prussian, Würtemberg, Baden and Bavarian ells. Gives calculations of cost, all involving a variety of standards. In the one for cotton tape there are the French inch, the English yard, the French line, the English pound and the meter.

Leipziger Monatschrift, October 31, 1902. A yarn calculation table based on the Vienna inch, English yard, English pound and the meter.

The same journal, July, 1903. An article on textile calculations in which are found the Saxon inch, English yard and pound and the metric standards.

Donat, 'Methodik der Bindungslehre,' Leipzig, 1901. Gives a list of standards in use in Germany which include the following: Leipzig, Bohemian, Berlin, Brabant, Vienna, English and French ells; English, Liepzig, French and Vienna pounds; Leipzig, English, Vienna and French inches.

Sixteen different systems of numbering yarn are in use in Germany based on the Berlin pound, the kilogram and half-kilogram, the English yard, the Berlin, Brabant and Leipzig ells and the meter.

Muenchner Allgemeine Zeitung, 1902. At the session of the tariff commission on June 24, 1902, the introduction of the metric system for cotton yarn came up for discussion. According to Abgeordnete Muench-Ferber, who is a manufacturer of cotton and woolen goods at Hof, Bayern, the introduction of the metric system would throw the German weaving industry into *heillose Verwirrung* because the German machinery is based on the English system.

In the light of this evidence as to the present conditions of German standards, those who seek the truth about the metric system have a right to ask for something more convincing than a repetition of the old story about a miraculous change in Germany thirty-four years ago. The evidence in conflict with that story can not be laughed to one side. The fact that the weights and measures of a great German industry are in a state of chaos to-day is proof that what we are asked to accept as the miracle of 1870 is, in fact, a myth of 1904.

Samuel S. Dale.

Boston, Mass.,
October 18, 1904.

VARIÆ AUCTORITATIS.

TO THE EDITOR OF SCIENCE: Mr. Emmons, in SCIENCE (October 21, p. 537), gives Professor K. von Zittel's 'History of Geology and Palæontology,' p. 3, as his authority for the statement that 'Origenes reports of Xenophanes of Colophon that he had observed sea-shells on mountains, etc.' But Ritter and Preller, 'Historia Philosophiæ,' §140, *a* (p. 86), are more correct in attributing the statement to 'Hippolytus, *Ref. Hær.*, I., 14.' The 'Philosophoumena, or Adversus omnes hæreses,' attributed formerly to Origenes, was proved by Bunsen in his 'Hippolytus and his Age' to have been the work of the latter. See Donaldson's 'History of the Literature of Ancient Greece,' Vol. II., p. 323, n. 1.

HENRY W. HAYNES.

BOSTON, October 29, 1904.

SPECIAL ARTICLES.

AN OVERLOOKED FORM OF STEREOSCOPE.

MODIFICATIONS of instruments, though in themselves not important, are often of interest as illustrating the variety of ways in which a given principle may be expressed in practise. This is notably true of the stereoscope, which as a practical instrument may be defined as any device that gives to each eye its appropriately different view and then enables the eyes to combine two views with facility. The oldest form of the apparatus, as is well known, was devised by Sir Charles Wheatstone in the year 1838, and consisted of two mirrors set nearly at right angles and of two separate and appropriately different views of the object (in the early experiments always two mathematically constructed diagrams) carried at the ends of two movable frames. The serious disadvantage of this apparatus was noticed by the inventor himself and consisted in the fact that the two views, being separated, required a troublesome adjusting to secure an exact combination of their images. A great improvement introduced in the present form of the apparatus, which was due to Sir David Brewster, was that the two views could be permanently fixed on a single card. It is rather interesting, even seventy years after the original discovery, to record that this advantage can be secured by a slight modification of the same principle which Sir Charles Wheatstone had so brilliantly demonstrated. It was, indeed, in reading his original account that the idea occurred to me of arranging the two mirrors in such a way that they would give proper reflections of two halves of the ordinary stereoscope card. The device will be easily understood from the accompanying diagram.

In using this device the eyes are placed just above the card which is turned with its back to the observer (Fig. 1). The slight inclination of the mirrors brings it about that each eye sees only one view of the card, while the

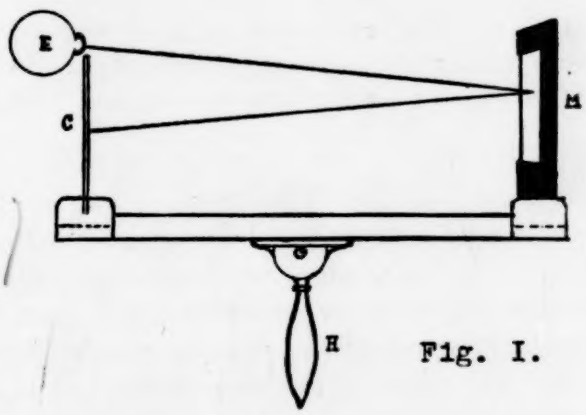


FIG. 1. The apparatus as seen from the side. *E*, the eye; *C*, the stereoscopic card; *M*, the mirror; *H*, the handle.

combination is easily effected by a proper convergence of the eyes to a common meeting point beyond the plane of the mirrors. It is an incidental feature of this device that it dispenses with the necessity of the bridge or screen which in an ordinary stereoscope is necessary to prevent each eye from seeing both views. This is unnecessary because the image of the other view of the card falls outside of the field of vision of the one eye.* There is no advantage to be maintained for this form of the stereoscope; indeed, it has a disadvantage which in certain cases is slight

* This is practically the case; yet with a full-sized stereoscopic picture (3–3¼″) there will be a small portion of the outer edge of the left-eye view visible to the right eye, and *vice versa*. This is not seriously disturbing, and could be eliminated by appropriate screens.

and in others more serious, of presenting a mirror reversal of the views. The views likewise appear somewhat small, though it would be easy to introduce lenses to magnify them. But the interest in the device is merely in its simplicity and in the fact that so direct an application of the Wheatstone plan should have lain so near at hand for so long a time and, to my knowledge, not have been intentionally sought for or accidentally hit upon by the many experimenters who have contributed to the literature of the stereoscope. And it is also fair to add that the practical preparation of a pair of mirrors at this angle is not an easy matter, if one is desirous of eliminating the seam or line at their point of junction the presence of which to some extent mars the perfection of the stereoscopic effect. It seems, however, worth while thus briefly to record the possibility of a reflecting stereoscope which is adaptable to the ordinary stereoscopic card. As a laboratory device for illustrating the variety of applications of the stereoscopic principle, it may possess interest if not value.

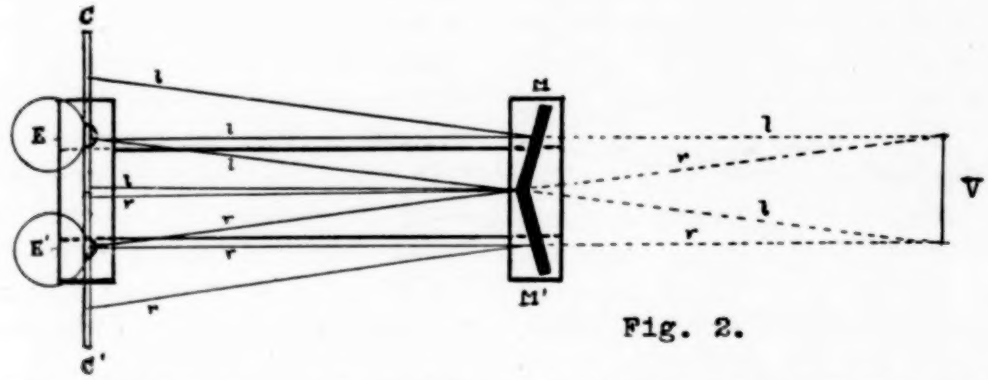


Fig. 2. The apparatus as seen from above. The letters as above: *V*, the combined view as projected by the eyes in stereoscopic vision; *r*, *r* and *l*, *l*, the paths of the rays in the right and left eyes from cards to mirrors and back.*

Joseph Jastrow.

University of Wisconsin.

* In this diagram no account is taken of a minor discrepancy due to the fact that stereoscopic photographers have agreed upon a separation (and size) of the stereoscopic views (3-3¼″) greater than the interocular distance (2¼-2½″). As a result practically so much of the views as corresponds to the interocular distance becomes completely stereoscopic, the marginal portions not participating in the stereoscopic effect. Yet for ordinary views this discrepancy is not serious; none the less the effect in views mounted within the limits of the interocular distance is distinctly more perfect.

THE NATURE OF THE ACTION OF DRUGS ON THE HEART (PRELIMINARY NOTE).*

The analysis of the nature of the action of drugs and certain inorganic substances in solution on the isolated heart of vertebrates is rendered difficult by the intimate connection of the nervous with the muscular elements in the heart, making it practically impossible to study the effects of a solution on the nervous elements apart from that on the muscle, and *vice versa*. In the heart of *Limulus* the relation of the nervous to the muscular elements is such that this analysis can be made. The heart of *Limulus* can be prepared in a manner allowing the determination of the nature of the action of a solution: (1) On the ganglion cells, (2) on the motor nerves, (3) on the motor nerve endings and the muscle.

I have shown elsewhere that in *Limulus* the origin of the heart-beat is nervous, not muscular, and that the coordination or conduction in the heart is effected through the nervous, not through the muscular tissue. I have some evidence that a similar mechanism of the heart-beat obtains also in the molluscs and the crustaceans, and I have little doubt that we shall have to revise the generally accepted theory of the function of the ganglion

* The experiments were performed at the Marine Biological Laboratory, Woods Hole, Mass.

cells even in the vertebrate heart. This must necessarily lead to a revision of some of our views of the nature of the action of drugs and certain solutions on the heart, as these are based on the myogen theory of the heart-beat.

The preparation of the *Limulus* heart for the study of the action of solutions on the ganglion cells apart from their effects on the muscle is represented in Fig. 1. The ganglion or median nerve-cord is extirpated from the first and second segments, the lateral nerves being left intact. The removal of the nerve-cord removes the ganglion cells from that part of the heart. The extirpation of the nerve-cord in the first two segments diminishes the strength of the contractions in these segments, but it does not affect the rate of the beats or the strength of the contractions in the other parts of the heart. After removal of the ganglion from the anterior end of the heart the contraction of the muscle in these segments is caused by impulses from the ganglion cells situated in the nerve-cord of the fourth, fifth and sixth segments, these impulses passing forward to the muscle in the lateral nerves. The heart-muscle may now be removed for a distance of one centimeter or more in the region of the second pair of lateral arteries, leaving the two ends of the heart connected by the lateral nerves only. The anterior end of the heart is supported and connected with a recording-lever for graphic registration in the manner indicated in Fig. 1.

By the removal of the nerve-cord and the separation of the heart-muscle in the second segment the action of a solution applied to the anterior end of the heart can not be due to or complicated by the effects of this solution on the ganglion cells, care being taken, of course, that the solution does not touch the posterior end of the heart. But although this possibility is excluded, the solution applied to the anterior end of the heart may affect the rhythm of this part of the heart in either or all of these three ways: (1) It may act directly on the muscle, (2) it may act on the motor nerves and nerve-endings, or (3) it may act on sensory nerves and nerve-endings, the impulses being carried to the ganglion cells in the posterior part of the heart by means of afferent fibers in the lateral nerves. This would be a true reflex action. I have positive proofs of the presence of such a local reflex mechanism in the *Limulus* heart.

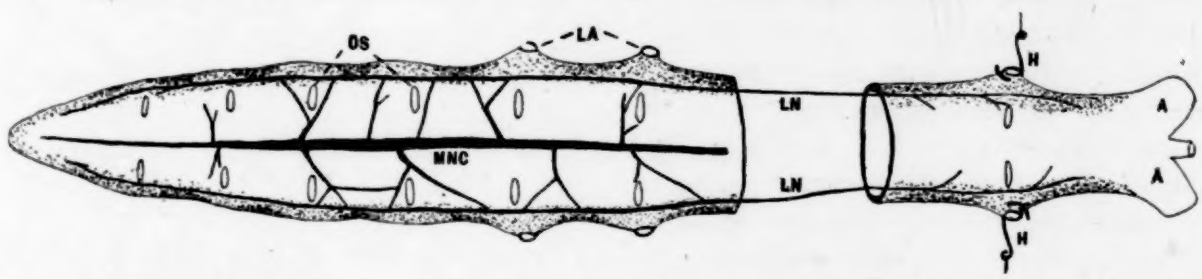


FIG. I. Heart of Limulus as prepared for studying the effects of solutions on the ganglion cells apart from that on the muscle. Dorsal view. *A*, anterior arteries; *LA*, lateral arteries; *LN*, lateral nerves; *MNC*, dorso-median nerve-cord or ganglion; *OS*, ostia; *H*, attachments for graphic registration of the contractions of the ganglion-free segments.

Conversely, if we apply the solution to the posterior end of the heart, that is, to the nerve-cord behind the lesion in the second segment, taking care that none of the solution reaches the isolated anterior end, the changes in the rhythm of the two anterior or reacting segments must be ascribed to changes in the activity of the ganglion cells due to the direct influence of the solution. It is possible to remove the greater part of the heart-muscle of the portion of the heart including the fourth to the seventh segments, leaving the nerve-cord, the lateral nerves and their main connections intact, without greatly disturbing the activity of the ganglion. The effects of the solutions on this isolated ganglion do not differ essentially from the effects

of applying the solution to the nerve-cord left in connection with the muscle. It is, therefore, probable that the solutions worked with act on the ganglion cells directly rather than indirectly by stimulation of sensory nerves or nerve-endings.

The alkaloids were dissolved in filtered plasma from the animal, or in sea water. Sea water is isotonic with the blood (Dr. Garrey) and is so slight a stimulant to the ganglion as to be almost neutral. On the heart-muscle I could not find that sea water had any effect.

The Effects of the Alkaloids on the Muscle.—Atropin, curare, pilocarpin and physostigmin of the strength of 1–100 in sea water or plasma have apparently no effect on the heart-muscle, the strength or the rate of the beats not being altered. Digitalin and nicotin of the same concentration produce extreme tonus contraction when applied to the ganglion-free segments. At a dilution of 1–1,000 digitalin applied to the muscle causes increased strength of the contractions, followed by a slight tonus. Nicotin produces tonus contraction even at the dilution of 1–2,000. Veratrin at the dilution of 1–1,000 causes an initial diminution of the amplitude of the beats, followed by strong tonus. At a dilution of 1–100,000 or 1–500,000 the amplitude of the beats is diminished, but no tonus contraction is produced. Aconite was worked with at a dilution of 1–100,000 and weaker; at that dilution it has apparently no effect on the muscle.

The Effects of the Alkaloids on the Ganglion Cells.—Atropin, curare, pilocarpin and physostigmin of the concentration of 1–100 (a strength which has practically no effect on the muscle) stimulate the ganglion cells intensely, the beats becoming very rapid and in some cases reduced to a minimum. The stimulating action of these drugs is best shown at a dilution of 1–500 or 1–1,000; at this concentration their effect on the nerve-cord is in the direction of augmenting the rate and the intensity of the nervous discharge from the ganglion cells, that is, the rate and amplitude of the beats in the ganglion-free reacting portion of the heart are augmented. The latent-time of the action of these drugs is very short, or from one half to five seconds, the shorter, the stronger the solution and the more excitable the nerve-cord.

Nicotin, digitalin, veratrin and aconite at the concentration of 1–100 stop the activity of the ganglion cells instantaneously. That this is a case of over stimulation or paralysis and not a true depressor action is shown by the fact that the stimulating action of these alkaloids is plainly evident on greater dilutions. Veratrin is the most intense stimulant of any of the alkaloids worked with. It must be diluted 1–1,000,000 or 1–2,000,000 in order not to kill or paralyze the ganglion almost instantaneously by over stimulation. At this great dilution it still causes great augmentation of the rhythm of the ganglion cells. Aconite stimulates the ganglion similarly at the dilution of 1–100,000 or 1–500,000; nicotin at the strength of 1–5,000 or 1–10,000; digitalin at the dilution of 1–1,000 or 1–2,000.

The latent period of the stimulation is short, or from one half to five seconds. At the dilution of one to two millions veratrin has often an initial depressor effect, which is invariably followed by acceleration or stimulation. Such an initial depressor action was not observed in the case of any of the other alkaloids.

None of these alkaloids proves fatal to the ganglion unless the application is long continued or their concentration great enough to stop the activity of the ganglion cells at once, and even in these cases the ganglion cells can usually be brought back to almost normal activity by continued bathing in plasma or sea water. After a bath of ten seconds in 0.5 per cent. nicotin, 1 per cent. digitalin, or 1/500 per cent. veratrin I never succeeded in restoring the ganglion.

The action of these alkaloids is, therefore, primarily on the ganglion cells in the heart rather than on the nerve-fibers or the muscle-cells. This is especially true of atropin, curare, pilocarpin and physostigmin, as these drugs have slight, if any, effect on the muscle and motor nerve-endings at the concentration of 1–100. And it is also true of the other alkaloids, or nicotin, digitalin, aconite and veratrin, for although these drugs act strongly

on the muscle even at a greater dilution than 1–100, their action on the nerve-cord is much more rapid and intense, and they, furthermore, act on the ganglion at a dilution which fails to affect the muscle. Part of the difference in the reaction of the muscle and the ganglion to these drugs is probably to be sought in difference in permeability of the muscle cell and the nerve cell.

The failure of these alkaloids (with the exception of veratrin) to produce initial inhibitory or depressor effects on the ganglion or the muscle is not due to the absence of an inhibitory nervous mechanism in the *Limulus* heart. Two pairs of inhibitory nerves pass from the posterior and dorsal surface of the peri-œsophageal ganglion to the median nerve cord on the dorsal side of the heart.

Before the action of these drugs on the ganglion and the heart muscle of *Limulus* was taken up an extensive study of the action of curare, atropin and nicotin on the molluscan and the crustacean heart had been carried out with the view of finding a drug that would paralyze the cardio-inhibitory nervous mechanism in these animals. None of the crustaceans or the molluscs allow a determination of the point of action of the drugs in the heart similar to the heart preparation of *Limulus*, but the reaction of the crustacean and the molluscan heart to these three alkaloids is identical with the reaction of the ganglion-free segments of the heart of *Limulus* on application of these drugs to the ganglion, which fact suggests that the relation of the ganglion cells to the heart-beat in these animals in no wise differs from that in the heart of *Limulus*.

We know of no drug which will paralyze the motor nerves or nerve-endings in the heart without destroying the excitability and contractility of the muscle. The heart-muscle responds to the stimulation of the nerves that pass from the nerve-cord to the muscle fifteen to twenty hours after the activity of the ganglion has ceased from exhaustion. After bathing the heart in one per cent. curare, one per cent. atropin, or one tenth per cent. nicotin for two or three hours the stimulation of these nerves is still effective. Nor does curare paralyze the motor nerve-endings in the body muscles of crustaceans and molluscs as maintained by some observers. In these animals curare acts like strychnia in the vertebrates, that is, causing primary excitation of the central nervous system, leading to tetanus and spasm and subsequent paralysis if the dose is sufficiently strong, but after such paralysis the body muscles still respond to stimulation of the motor nerves.

Alcohol in concentrations of 1–100 or 1–200 stimulates the ganglion cells both as regards the rapidity and the intensity of the nervous discharges.

The Action of Certain Inorganic Salts on the Ganglion Cells.—Barium chloride, rubidinum chloride, potassium chloride and sodium chloride stimulate the ganglion cells, the chlorides of calcium and cæsium depress the activity of the ganglion without primary stimulation.

When the nerve-cord is removed from the heart and the heart immersed in isotonic ($\frac{5}{8}$m.) sodium chloride the heart begins to contract more or less rhythmically after a latent period of from thirty to forty-five minutes. The addition of a small amount of calcium chloride prevents the development of this rhythm or stops it after it is once developed. The action of these salts on the ganglion-free heart-muscle of *Limulus* is thus identical with their action on the apex of the frog's or the tortoise's ventricle. The $\frac{5}{8}$m. NaCl solution applied to the nerve-cord stimulates at once or after a latent time of less than a second. The stimulation of the ganglion cells appears in increased rate as well as amplitude of contraction, the amplitude of the beats becoming gradually diminished, until after ten to fifteen minutes the activity of the ganglion ceases completely. A small amount of calcium chloride counteracts the stimulating and subsequent depressor action of the pure sodium chloride.

Calcium chloride in isotonic concentration down to a dilution represented by one part $CaCl_2$($\frac{5}{8}$m.) to twenty parts of sea water or plasma depresses the activity of the ganglion cells. This effect appears immediately on application of the solution to the ganglion.

When the strength of $\frac{5}{8}$m. is used the activity of the ganglion stops short at once, or a few diminutive beats separated by greatly prolonged diastoles precede the complete abolition of the activity. In weaker concentrations the depressor actions on the ganglion cells appear only in diminished rate and amplitude of the contractions in the reacting portion of the heart. After complete abolition of the activity of the ganglion by $CaCl_2$ the normal activity can be restored by bathing with plasma, sea water or isotonic sodium chloride solution. The resumption of functional activity is very gradual.

The action of calcium chloride on the ganglion is almost duplicated by that of cæsium chloride, only that the latter salt does not appear to depress quite as strongly as the former. The recovery of function is also somewhat quicker after the cæsium chloride bath. At $\frac{5}{8}$m. concentration cæsium chloride stops the activity of the ganglion almost at once, but in concentrations represented by one part of $\frac{5}{8}$m. of the salt to ten or twenty parts of sea water or plasma the depressor action appears in diminished rate and amplitude of the beats. The depressor action of this salt on the ganglion cells is further shown by its antagonism to the stimulating action of the alkaloids veratrin, aconite, niconite and digitalin. The addition of cæsium chloride to the solutions of these drugs greatly decreases their stimulating power, and bathing the nerve-cord in isotonic (or even weaker) solutions of the chloride after previous application of the alkaloid solutions quickly counteracts their stimulating effects.

The most powerful stimulants to the ganglion cells are the chlorides of barium, potassium and rubidinum. It is very difficult to work with the chloride of barium because of the fact that the barium is precipitated by the sulphates in the plasma or sea water. The isotonic solution of the salt can not, therefore, be diluted with either sea water or plasma, but a dilution is necessary to study its effect on the ganglion cells because the $\frac{5}{8}$m. concentration stops their activity instantaneously. This is due to over stimulation or paralysis. The barium chloride solution was diluted with a mixture of fifteen parts of $\frac{5}{8}$m. NaCl to one part $\frac{5}{8}$ m. $CaCl_2$. This mixture proved nearly neutral for the nerve-cord. The addition of even one part of barium chloride to twenty parts of this mixture produced a marked augmentation of the rate and strength of the beats, which under the conditions of the experiments meant an augmentation of the rate and intensity of the nervous impulses reaching the muscle. Rubidinum chloride stimulates the nerve-cord at a dilution represented by one part of the $\frac{5}{8}$m. solution to twenty parts of sea water or plasma. The isotonic solution of the salt stops the activity of the ganglion instantaneously.

The $\frac{5}{8}$m. solution of the chloride of potassium stops the activity of the nerve-cord at once, just like the similar solutions of the chlorides of barium and rubidinum. Even at the dilution of one part of the potassium chloride solution to five parts of sea water or plasma the activity of the ganglion is usually arrested immediately, that is, without previous stimulation. That this is not a true depressor action is shown by the fact that at greater dilutions a strong stimulating action appears. At a concentration of one part $\frac{5}{8}$m. KCl to twenty parts of plasma the rate and strength of the beats are greatly augmented and this stimulating action is maintained for a relatively long time. Potassium chloride is a much greater stimulant to the nerve-cord than is sodium chloride. The concentration of the latter salt, represented by one part $\frac{5}{8}$m. NaCl to twenty parts of sea water or plasma, has no appreciable effect on the nerve-cord. Yet under some conditions potassium chloride appears to have a true depressor action. When the ganglion has been bathed for some time in a solution of one part $\frac{5}{8}$ m. KCl to twenty parts of sea water and this solution replaced by sea water for some minutes, a reapplication of the former solution to the ganglion may result in a partial depression of the activity preceding the stimulation. The action of the potassium ion is thus a complicated one and in part determined by the condition of the ganglion cells.

Application of distilled water to the nerve-cord causes great acceleration of the rate of

the beats. This may be accompanied by an increased amplitude of the contractions for a few seconds, but the contractions become diminutive very quickly, and the rapid diminutive beats are followed by a prolonged diastole. The function of the nerve-cord is restored by plasma or sea water.

A. J. CARLSON.

UNIVERSITY OF CHICAGO.

QUOTATIONS.

THE COLLEGE YEAR.

THE beginning of the college year, a month ago, brought several interesting facts under discussion. For instance, in almost every college there was an increase in the number of students—in some colleges a very large increase. The demand for higher training keeps pace with the growth of wealth and population—perhaps outruns it, by mere physical measurement. Endowments and gifts to colleges continue to be made in ever-increasing sums. Yet the demands, especially of the larger universities, become greater every year. Columbia University, in New York City, for instance, has immediate need of more than two millions of dollars; and President Wilson, of Princeton, it will be recalled, formulated a plan of enlargement and improvement, last year, that calls for about twelve millions.

Dr. Alfred G. Mayer, a little while ago, put into concise form in SCIENCE the statistics of higher education in the United States, which show that the number of our universities and colleges in 1902 was 638, and the number of students, including graduate students, was 112,433. The number of colleges has increased by 50 per cent., and the number of students by about a hundred per cent., during the decade. But how small a part the college-bred are of the whole population is yet somewhat startling, for they comprise but one in every 700. There were twice as many teachers in 1902 as there were in 1889. The value of college property was multiplied by almost three; the endowment funds were two and a half times as great; gifts for other purposes were nearly three times as great; and the total income, exclusive of benefactions, was more than trebled. The number of books and libraries was doubled.

In spite of this increased prosperity, the average salary of teachers has probably declined. In one of our largest universities, the average, ten years ago, was $1,500. It is now only $1,257. In another one, the average was $1,454, and now it is $1,355. This low average has been caused by the engagement of an increasing number of instructors and other subordinate members of the teaching force. The salaries of the professors themselves have not declined, but the increasing proportion of college instruction is now done by subordinate members of the faculties. Sir William Ramsay, during his recent visit to the United States, made more than one plea for increasing the salaries of teachers of high grade.

College training, except in those universities that are maintained by the states, is yet paid for by rich men and dead men. The students, even at those institutions where fees are highest, pay not more than one third of the cost of the training that they receive. It is an industry that must yet be endowed—a fact that hints of its ecclesiastical history. In the perfect economic state, the state will pay for the training of all its children. But we need not yet bother ourselves about the ideal economic state. There is enough work for us to do in training well as large a number of capable youth as possible, at the expense of rich men, living or dead, at the expense of the state, or in any other way, if only enough youth be trained, and be trained well enough.—*The World's Work* for November.

BOTANICAL NOTES.

BOTANY AS A FACTOR IN EDUCATION.

IN a suggestive and helpful article in the October number of the *School Review* Professor J. M. Coulter discusses botany as a factor in education, noticing first its special function in secondary education, and then its general function as a representative scientific study. He says truly that since plants enter very largely into human experience their study 'must relate the pupil to his most common

experiences.' That plants 'reveal the fundamental laws of life,' that they 'are favorable for biological experiment' and that they present opportunities for the study of 'mass phenomena' (ecology, sociology), suggest the culture value of botanical study. As a representative scientific study botany may aid in the cultivation of the scientific spirit, which keeps close to the facts. In commenting upon this, the author says: "We are not called upon to construct a theory of the universe even upon every well-attested fact, and the sooner this is learned the more time will be saved and the more functional will the observing powers remain." "Facts are like stepping-stones; so long as one can get a reasonably close series of them he can make some progress in a given direction." And again, "As one travels away from a fact its significance in any conclusion becomes more and more attenuated. * * * A fact is only influential in its own immediate vicinity." Yet without some corrective training many a man starts with a single well-attested fact and from it constructs an elaborate system. "There is danger of setting to work a mental machine without giving it suitable material upon which it may operate. * * * It may not be that laboratory science in education is the only agency, apart from common sense, which is correcting this tendency; but it certainly teaches most impressively by object lessons which are concrete, and hence easiest to group, that it is dangerous to stray away very far from the facts, and that the farther one strays away the more dangerous it becomes, and almost invariably lends to self-deception."

THE BIRCHES.

HUBERT WINKLER's contribution to Engler's 'Pflanzenreich' is a notable addition to our knowledge of the birches and their allies. The family (Betulaceae) is divided into two tribes, Coryleae and Betuleae. In the first are the small genera *Ostryopsis* (1 species), *Ostrya* (2 species), *Carpinus* (18 species) and *Corylus* (8 species). In passing we notice that our American *Ostrya* is hereafter to be known as *O. italica* Scopoli, subspecies *virginiana* (Mill.) H. Winkler. In the second tribe the dominant genera *Betula* (38 species) and *Alnus* (17 species) are figured and described. That the treatment is conservative is shown by the fact that of the 84 species described but 9 are new! These are *Carpinus schuschaensis, C. londoniana, C. paxi, C. stipulata* (all from China), *C. grosserrata* (Persia), *C. hybrida* (Transcaucasia), *Betula luminifera, B. baeumkeri* (both from China) and *B. rosae* (Korea). One can not help admiring the author who has the ability to work over a group such as this, and not find it necessary to split up the common species. It is very certain that there are botanists who would have discovered a dozen valid (?) species in *Ostrya italica*, as many more in *Carpinus betulus* and still more in *Corylus avellana*, to say nothing of the possibilities in *Betula* and *Alnus!*

FORESTRY NOTES.

THE 'Forest Manual' is the title of a useful booklet of sixty-four pages issued by the Bureau of Forestry of the Philippine Islands. It contains the forest act which took effect May 20, 1904; extracts from other acts and regulations of the Philippine commission in reference to the forests and their management; lists of native trees; directions for measuring, etc. The United States Bureau of Forestry has issued a bulletin (No. 52) on 'Forest Planting in Western Kansas,' prepared by R. S. Kellogg. After a year or so of careful investigation he says: 'Whatever may be the reasons for the absence of natural forests on the great plains, a close study of established plantations proves that, with an intelligent selection of species and proper care, planted trees can, to a considerable extent, be made to supply the deficiency.' The bulletin abounds in valuable suggestions as to the salvation of species and methods of planting. About twenty-five species are favorably mentioned, including honey locust, osage orange, Russian mulberry, green ash, red cedar, white elm, pines (Scotch and Austrian), black locust, hackberry, cottonwood, box elder, silver maple, black walnut, catalpa, etc.—Bulletin 46 of the Bureau of Forestry is devoted to the growth and management of

the basket willow (by W. F. Hubbard) and Bulletin 53 to the occurrence, soil-requirements and cultivation of the chestnut in southern Maryland. Both papers are well written and must prove very useful.—In the St. Louis World's Fair the Bureau of Forestry has made an outdoor exhibit including a demonstration forest nursery, covering about one fifth of an acre of ground. This valuable exhibit has been made still more valuable by the publication of a descriptive circular (No. 31) in which the plan of the work is clearly explained.—Professor Stanley Coulter and H. B. Dorner have published a handy 'Key to the Genera of the Forest Trees of Indiana,' based chiefly upon leaf characters. It makes a twelve-page pamphlet, which should be very useful to foresters and others interested in trees.—We may close these notes on trees by a reference to a curious book which has lately come to hand, 'The Tree Doctor,' by John Davy. In a book of 87 pages and 167 halftone photographs, the author gives us a medley of sense and nonsense, good practical advice and suggestion, and wild theorizing, in English which is often quite as unorthodox as his science. The author evidently knows how to grow and care for trees, but he has not succeeded very well in telling us how he does it.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

INDUSTRIAL EDUCATION IN GERMANY.

MR. ERNST C. MEYER, U. S. Deputy Consul at Chemnitz, writes as follows to the Department of Commerce and Labor in regard to the relative part taken by private initiative and state aid in industrial education in Germany:

It was quite uniformly true that in the establishment of industrial schools private initiative took the lead. The state generally held back until the private schools had proved their usefulness. Then followed a state subsidy and a general supervisory power, and finally most of the industrial schools of higher rank passed over entirely into the hands of the state. The German deserves great credit for his enterprise and discerning powers in the field of industrial education. Many important trade and commercial schools of to-day were, at the time of their establishment by private individuals, attacked as wild fantasies. Not infrequently state aid was refused, and the individual was compelled to make the best of his own educational views until time vindicated his course. It is not too much to say that to private enterprise probably belongs the greatest credit in the development of Germany's unrivaled system of industrial schools. It was the chambers of commerce, the commercial organizations, the special trade organizations, the guilds, public-spirited benefactors, and men of wide educational discerning powers that contributed most in the construction of the splendid system of industrial schools.

Nor can this reasonably be interpreted as a criticism against the attitude assumed by the state. Records show that this attitude from the first, though not aggressive, was not hostile or condemning, but highly favorable to the establishment of industrial schools. It was probably great wisdom on the part of the state to avoid criticism at a time when criticism against industrial schools was particularly severe, to hold back and let private enterprise prove the value and efficiency of the schools before extending its own powerful aid and protection. To-day every government in the Empire is intensely interested in the welfare of the industrial schools. The time of experimentation as to their value is past. It is now a question of how most economically, most efficiently, and most rapidly to further develop these schools. Though private initiative in the early days broke the way, the state is to-day not delinquent in following out the advantages of early private experience.

The various governments exercise a powerful influence over the organization and work of the industrial schools and the dispensation of their subsidies. The allowance of a subsidy is generally conditioned upon the meeting of certain requirements in organization, entrance requirements, curriculum and grade of work. Schools which conform to the stipulated requirements enjoy financial aid, while others are assured of like aid as soon as the demands of the state are met. By this means it has been possible to introduce great uni-

formity into the numerous private institutions. The adopted standards are maintained and enforced by the state through an efficient system of inspection. Lagging institutions are threatened with the withdrawal of their subsidies, while efficient work receives recommendation. The public is kept informed of the entrance requirements, work, aims and discipline of the schools through the systematic publication of complete catalogues. Every industrial school, from the lowest trade school to the technical high schools, annually issues its courses of study, entrance requirements, tuition fees, final examination regulations, disciplinary codes, and all other matter of interest and importance to those who contemplate sending their sons or daughters to a trade school. Where a strict discipline is maintained, and no academic freedom permitted, as in all the lower trade schools, the catalogues invariably contain all the school statutes regulating the conduct of students in attendance. Special notice is given to parents that by sending their son to the school they imply an agreement to abide by the disciplinary code of the institution which, while not oversevere, is generally quite rigorous and keeps the young student within strict bounds of life.

THE JOHNSTON SCHOLARSHIPS OF THE JOHNS HOPKINS UNIVERSITY.

THESE scholarships, of which there are three, known as the Henry E. Johnston, the James Buchanan Johnston and the Henry E. Johnston, Jr., scholarships, were founded by Mrs. Harriet Lane Johnston, of Washington, formerly of Baltimore, in memory of her husband and her two sons. They are awarded annually by the trustees on the recommendation of the academic council. The stipend of each scholarship is the income of thirty thousand dollars. They are offered primarily to young men who have given evidence of the power of independent research. The holders will be expected to devote themselves to study and to research in their chosen subjects, though they may be required to do some teaching. Candidates for the scholarships must make application in writing, to the president of the Johns Hopkins University before the first of May. The application must be accompanied by such evidence of the candidate's fitness as he may be able to present. The president will refer the papers to the academic council, by whom the nomination will be made to the board of trustees, at their meeting in June. Holders of the scholarships may not engage in teaching elsewhere. The scholars will be appointed for one year, but if their work should prove satisfactory, they will generally be reappointed. Applications for the present year will be received up to January, 1905.

THE NEW YORK HISTORICAL SOCIETY.

ON November 2 the president of the New York Historical Society announced the gift of about $200,000 towards the erection of the new building of the society, on ground already owned by them at Seventy-sixth and Seventy-seventh Streets and Central Park, West, New York. The foundations for the central portions of the new building are already constructed, costing some $70,000, and with the money in the treasury, $92,000, available for the new building, work has now been begun to erect a thoroughly modern building for the housing of the treasures of this society. The donor desired his name to be withheld, but the papers announce that it is Mr. Henry Dexter, who was one of the founders of the Metropolitan Museum, and his gift, $150,000 in cash and about $50,000 worth of granite, is in memory of his son, Orrando Dexter, who was killed in the Adirondacks. The society is one hundred years old on November 20, and this gift places it in a position where it can progress in its work in a more satisfactory manner than before. Few people know that this society possesses one of the finest art galleries in America, and a collection of Egyptian antiquities which Miss Amelia B. Edwards pronounced as the finest outside of Egypt and surpassing them in some lines. Of old New York history they are unsurpassed, but working quietly, their collection is overlooked except by the expert.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. SECTION C.

OWING to the large number of papers annually presented at the joint meeting of the American Chemical Society and Section C and the utter impossibility of reading them all with any hope of a proper appreciation of their contents, a radical change has been adopted in the arrangement of the program for this winter's meeting.

The time to be devoted to papers has been divided about equally between general meetings and meetings of subsections and the subsections have each been put in charge of a leader of wide reputation in the special department over which he presides. It is hoped thereby to arouse an increased interest in the hearers and particularly to stimulate discussion. Also it is hoped to increase the social intercourse and acquaintance of chemists who are working along the same lines of investigation.

At the same time the advantage of the general session is not to be lost sight of and the leaders of the subsection will recommend special papers of broad and general interest from among those presented to them to the sectional committee for a place on the general program. Details will be left to the subsections where they may be adequately discussed.

The leaders chosen for this year are: Dr. Arthur A. Noyes, physical and electro-chemistry; Dr. Jas. Lewis Howe, inorganic chemistry; Dr. James F. Norris, organic chemistry; Dr. Edward Hart, industrial chemistry; Dr. William P. Mason, sanitary, physiological and agricultural chemistry.

Abstracts of papers intended for the meeting may be mailed to me or may be sent direct to the leaders of the subsections. But one program is to be printed for this meeting, and to insure insertion all abstracts should be sent in time to reach me, directly or indirectly, before December 10.

CHARLES LATHROP PARSONS,
Secretary Section C.

DURHAM, N. H., November 9, 1904.

TRIMMED COPIES OF SCIENCE.

AT a recent meeting of the committee on the policy of the association, it was recommended 'That the publishers of SCIENCE be requested to announce prominently that cut copies will be sent to members who request it.' Trimmed copies of SCIENCE are now supplied to the news companies and to all subscribers who express a preference for them. Those who prefer trimmed copies should address a postal card to The Macmillan Company, 66 Fifth Avenue, New York City, and they will be thereafter sent.

Some subscribers to SCIENCE may wonder why all copies are not trimmed. It is not to save the cost, which is trifling, probably not more than the saving in postage. There are two reasons. One is that the copies can be bound to better advantage when they are untrimmed. The other appeals with unequal force to different people. It is largely a matter of tradition and association. The best journals and magazines have in the past been untrimmed, while the cheaper and more transient publications have been trimmed. An untrimmed journal looks to some of us as if it were ready for the binder and the library shelf, a trimmed copy as if it were half way to the waste paper basket. The larger margins look better, and the uneven edges represent the difference between objects that are hand-made and those that are machine-made. For the same reasons, SCIENCE is not wired, but sewn, though the cost is a little more. *Nature* has recently been trimmed and wired, the convenience being gained at a certain intangible loss of dignity and authority. The utilitarian will doubtless prevail over the esthetic in the end, and the argument from tradition and association will gradually lose its force. But SCIENCE is reluctant to break with its past and with a long literary tradition. Such conservatism may seem unreasonable, but it is at least harmless, so long as every one who wishes can receive trimmed copies.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR E. RAY LANKESTER, director of the Natural History Museum, London, has

been appointed Romanes lecturer at Oxford for the coming year.

Dr. Hermann Struve, director of the observatory and professor of astronomy at the University of Berlin, has been elected member of the Berlin Academy of Sciences.

Mr. H. H. Jeffcott has been appointed assistant in the metrological department of the British National Physical Laboratory.

Lord Kelvin distributed the prizes to the prizemen of St. George's Hospital Medical School on October 28.

A Japanese imperial medical commission has been making a tour of the health departments of the principal cities of this country and Europe. The commission consists of Dr. Takamine, professor of chemistry in the Imperial University at Tokio; Professor Tanva, of the department of pharmacy, and Dr. Sato, chief surgeon at the university.

Dr. W. A. Kellerman, head professor of botany in the Ohio State University, will spend January, February and March in Guatemala, studying and collecting the parasitic species of fungi of the native and cultivated plants of that country.

Captain Scott, R. N., and the officers of the *Discovery* Antarctic expedition were present at the opening of the Antarctic Exhibition of water colors, photographs and other articles of interest used in the South Polar regions during their recent expedition, which took place at the Bruton Galleries on November 4. Sir Clements Markham, president of the Royal Geographical Society, opened the exhibition.

Major Powell Cotton is about to start on an eighteen months' African expedition to explore the country lying between the Nile and the Zambesi.

Sir John Murray gave this week at Harvard University two lectures on 'Problems in Oceanography.'

On November 16 Dr. J. H. Woods, gave the first of three public lectures arranged by the Harvard Anthropological Society, speaking on 'Ghost Worship and Buddhism in India.' The other lectures in the series will be as follows: on December 2, 'The Characteristics of Primitive Culture,' Dr. Franz Boas, of Columbia University; on December 7, 'The Maya Hieroglyphs of Central America,' Mr. C. P. Bowditch, '63.

Dr. George T. Moore, director of the Laboratory of Plant Physiology of the U. S. Department of Agriculture, addressed the American Philosophical Society, at Philadelphia, on October 21, on 'A new method for the purification of water supplies.'

Dr. D. W. Johnson, of the Massachusetts Institute of Technology, has just completed a report on the 'Relation of the underground waters to the law.' It will be published in the reports of the eastern section of the Division of Hydrology of the United States Geological Survey.

The United States Geological Survey has just completed an arrangement with Dr. T. L. Watson, the recently appointed state geologist of Virginia, for cooperation in the investigation of the artesian waters of that state. These investigations will be carried on during the winter and following summer by Mr. M. L. Fuller, of the United States Survey, in conjunction with Dr. Watson, of the State Survey, and a joint report will be prepared early in the fall of 1905.

In addition to the commemoration of the two hundredth anniversary of the death of John Locke at the Johns Hopkins University, to which we have already called attention, the event was commemorated at the George Washington University, on November 12, under the auspices of the Society for Philosophical Inquiry. The program was as follows:

'Locke on Government': President Needham, of the George Washington University.

'Locke's Influence on Modern Psychology': The Rev. Dr. E. A. Pace, of the Catholic University of America.

Locke's Metaphysics of Causality and Space': Dr. Wm. T. Harris, U. S. Commissioner of Education.

'Locke's Personality': Hon. Frank Warren Hackett.

'Locke as a Physician': Dr. William Osler, of Johns Hopkins University.

Samuel W. Woodhouse, M.D., died in Philadelphia, Pa., on October 23, in his eighty-fourth year. He made explorations

in New Mexico and Arizona in the early fifties. Woodhouse's Jay (*Aphelocoma woodhouseii*) was named after him more than forty years ago by Professor Baird.

MR. GEORGE HENRY WITH, of Hertford, England, known for his scientific work, and especially for his specula for reflecting telescopes, has died at the age of seventy-seven years.

DR. HUGO HUPPERT, professor of physiological chemistry at Prague, died on October 19, at the age of sixty-three years.

THE Carnegie Museum has acquired by purchase for its library the collection of books and pamphlets on vertebrate paleontology made by the late Professor J. B. Hatcher, and the collection of writings upon invertebrate paleontology belonging to the estate of the late Professor C. E. Beecher, of Yale University. The acquisition of these two important working libraries, together with the large purchase of books on paleontology made by the museum in recent years creates in Pittsburg the nucleus of an exceedingly useful collection of works on the sciences to which Professor Hatcher and Beecher devoted themselves.

THE Messrs. Nicola Brothers, of Pittsburg, have presented to the Carnegie Museum a magnificent tusk of a mastodon found on their property at Sharon, Pa. Director W. J. Holland, of the museum, says it is one of the most beautifully preserved and perfect pieces of fossil ivory ever found in America, preserving its whiteness and grain in a splendid manner.

THE University of Chicago has been awarded Grand Prizes at the St. Louis Exposition as follows: (1) on the general exhibit; (2) on the work of the university press; (3) on the work of the Yerkes Observatory; and (4) on Professor A. A. Michelson's physics instruments.

Nature states that the Naples Academy of Physical and Mathematical Sciences offers prizes of 500 francs to the authors of the best papers in Latin, French or Italian on the two following subjects: the processes of formation of urea in the animal organism, and the evolution of the ovaric ovum in the Selacii. The essays are to be sent in anonymously, bearing a motto, on or before June 30, 1905. The Padua Society of Encouragement offers, to Italian subjects only, two prizes of 5,000 francs for an essay on the present state of the problem of electric traction on railways, and for a new method of diagnosing the disease of pellagra previous to its development. This competition closes on June 30, 1906.

THE London *Times* states that the steamer *Veronique*, of 3,264 tons, purchased by Lord Fitzwilliam, has sailed from Southampton on an exploring expedition in the Pacific *via* the Straits of Magellan. Lord Fitzwilliam and party embarked in the steamer, which is under the command of Captain E. Morrison, with a crew of 58 hands. It is said that the ship's destination is the Solomon Islands, where coal mines are reported to have been discovered.

THE American Association of Agricultural Colleges and Experiment Stations, met at Des Moines, Ia., last week. Officers were elected as follows: *President*, E. B. Voorhees, director of the New Jersey Experiment Station; *first vice-president*, G. C. Hardy, president of the Mississippi Agricultural College; *secretary and treasurer*, J. Hills, Vermont.

THE annual general meeting of the British Astronomical Association was held on the evening of October 26, Mr. S. A. Saunder, the outgoing president, in the chair. The election of the following as officers and members of the council for the session 1904–5 was announced: *President*, Mr. A. C. D. Crommelin; *vice-presidents*, Mr. E. W. Maunder, Mr. S. A. Saunder, Mr. G. M. Seabroke and Mr. C. T. Whitmell; *treasurer*, Mr. W. H. Maw; *secretaries*, Mr. J. G. Petrie and Mr. J. A. Hardcastle; *librarian*, Mr. F. W. Levander; *other members of the council*, Mr. C. L. Brook, Mr. A. Cottam, Mr. Tyson Crawford, Mr. H. Ellis, Mr. W. Heath, Mrs. E. W. Maunder, Mr. G. J. Newbegin, Mrs. Isaac Roberts, Dr. D. Smart and Mr. C. Thwaites.

UNIVERSITY AND EDUCATIONAL NEWS.

PARK COLLEGE, near Kansas City, has received an additional endowment of $100,000,

of which $25,000 has been given by Dr. D. K. Pearson.

At a recent meeting of the trustees of Columbia University gifts aggregating $46,850 were announced by the trustees. Among these was the sum of $15,000 from Gen. Horace W. Carpentier, of the class of 1848, to be added to the fund for the endowment of the chair of pediatrics, established at the College of Physicians and Surgeons by General Carpentier. Two other gifts were of $10,000 from the family of the late Dr. Guy B. Miller, M.S., '98, for the Medical School, and of $20,000 from an anonymous donor for a large plaster model of the university buildings and grounds for permanent exhibition.

An anonymous donor has sent a £1,000 Bank of England note to the treasurer of University College, Bristol.

Mr. Francis Galton, F.R.S., has founded in London University a fellowship for the promotion of the study of 'National Eugenics,' 'the study of the agencies under social control that may improve or impair the racial qualities of future generations, either physically or mentally.'

A new technical institute was opened at Danzig by the German Emperor on October 6. It has been built by the state at a cost of over $1,700,000 on land presented by the city of Danzig. It will have six faculties—architecture, building engineering and machine engineering, chemistry, general science and shipbuilding.

The statute for exempting from Greek candidates for the honors schools of natural science and mathematics, at Oxford, which is based upon the resolutions passed by congregation, on February 9, when the voting was 164 to 162, will be promulgated on November 29.

Edward H. Kraus, B.S. (Syracuse, '96), Ph.D. (Munich, 01), has been appointed assistant professor of mineralogy in the University of Michigan in the vacancy caused by the death of Professor W. H. Pettee.

Mr. E. D. Grant, who for some time past has been instructor in the department of mathematics and physics of the Michigan College of Mines, has recently been made assistant professor in the same department.

Dr. Andrew Sledd, A.M. (Harvard), Ph.D. (Yale), has been called to the presidency of the University of Florida, Lake City, Florida (formerly the State Agricultural College). The following appointments are also announced: Edward R. Flint, Ph.D. (Göttingen), M.D. (Harvard), professor of chemistry; M. T. Hochstrasser, M.E. (Georgia School of Technology), professor of mechanical engineering and drawing; F. M. Rolfs, B.S. (Iowa State College), M.S. (Colorado Agricultural College), professor of botany and horticulture; Karl Schmidt, Ph.D. (Marburg), professor of mathematics and astronomy; E. H. Sellards, A.M. (Kansas State University), Ph.D. (Yale), professor of entomology, geology and zoology. Two hundred and five students are enrolled, a substantial increase over former years. A new brick dormitory, 40 x 100 feet, replacing Foster Hall, burned in December, 1903, was opened for occupancy on November first. An effort is being made to develop the several departments on a university basis.

Mr. E. D. Sanderson, recently state entomologist of Texas and professor of entomology of Texas Agricultural and Mechanical College has resigned, and has assumed work at Durham, N. H., as professor of zoology at the New Hampshire College and entomologist of the Experiment Station.

Professor Bertram C. A. Windle, F.R.S., dean of the medical faculty and professor of anatomy in Birmingham University, has been appointed president of Queen's College, Cork, in succession to Sir Rowland Blennerhasset.

Mr. Alfred Young, lecturer in mathematics in Selwyn Hostel, Cambridge, has been elected to a fellowship of mathematics in Clare College.

Professor Primrose McConnell has been appointed lecturer in the Winter School of Agriculture, under the Essex Education Committee, in succession to Mr. W. Angus, appointed to the professorship of agriculture at Adelaide.